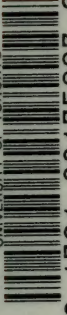
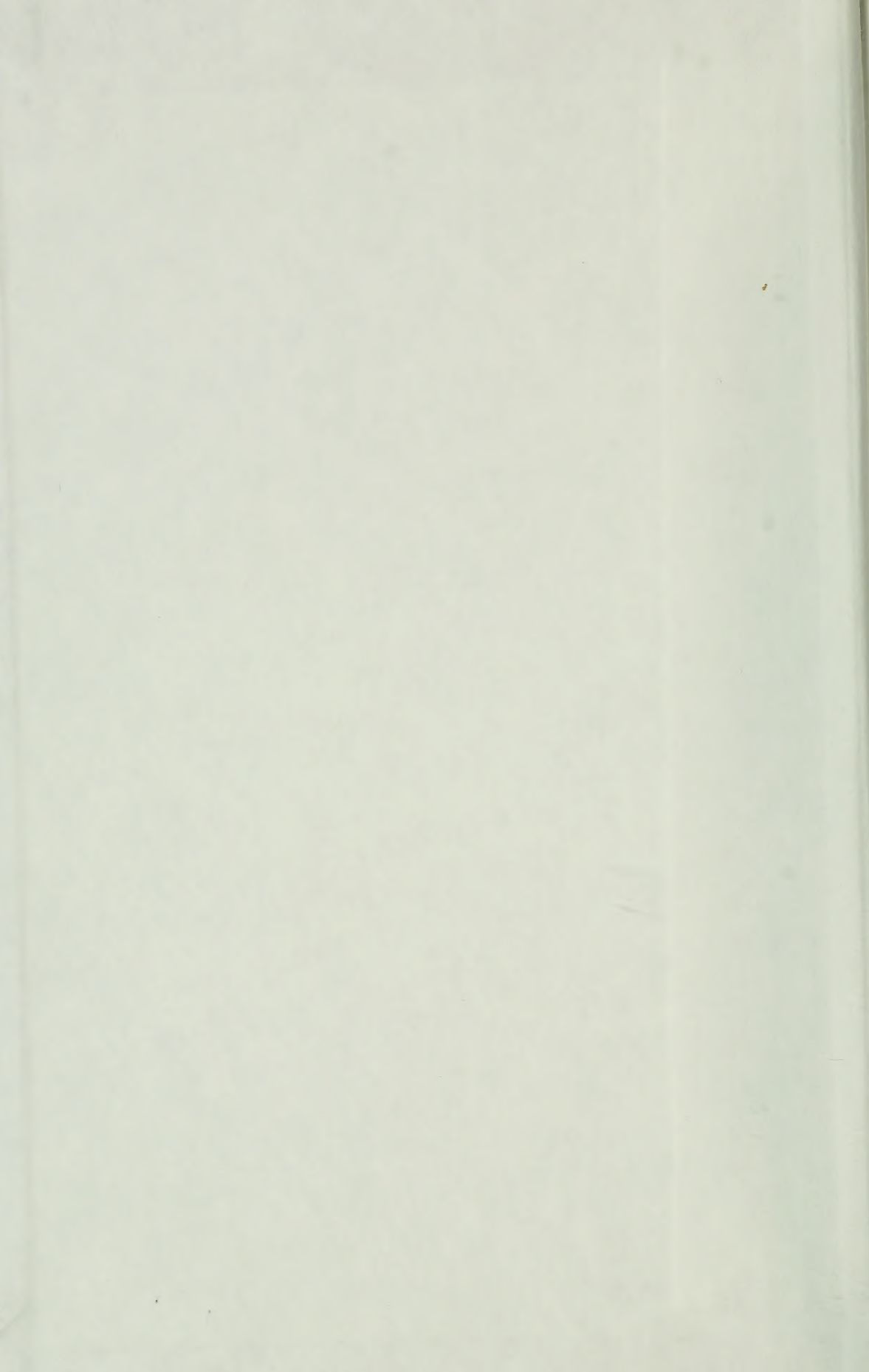



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STUDIES
IN THE
HISTORY AND METHOD
OF SCIENCE

17

OXFORD UNIVERSITY PRESS

LONDON EDINBURGH GLASGOW NEW YORK
TORONTO MELBOURNE CAPE TOWN BOMBAY

HUMPHREY MILFORD

PUBLISHER TO THE UNIVERSITY



Plate I. HILDEGARD RECEIVING
THE LIGHT FROM HEAVEN

STUDIES
IN THE
HISTORY AND METHOD
OF SCIENCE

EDITED BY
CHARLES SINGER

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OXFORD
AT THE CLARENDON PRESS
1917

PRINTED IN ENGLAND
AT THE OXFORD UNIVERSITY PRESS

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INTRODUCTION

THE record of men and of movements, History teaches us the growth and development of ideas. Our civilization is the final expression of the two great master-thoughts of the race. Seeking an explanation of the pressing phenomena of life, man has peopled the world with spiritual beings to whom he has assigned benign or malign influences, to be invoked or propitiated. To the great 'uncharted region' (Gilbert Murray) with its mysteries, his religions offer a guide; and through 'a belief in spiritual beings' (Tylor's definition of religion) he has built an altar of righteousness in his heart. The birth of the other dominant idea, long delayed, is comparatively recent. 'The discovery of things as they really are' (Plato) by a study of nature was the great gift of the Greeks. Knowledge, *scientia*, knowledge of things we see, patiently acquired by searching out the secrets of nature, is the basis of our material civilization. The true and lawful goal of the sciences, seen dimly and so expressed by Bacon, is the acquisition of new powers by new discoveries—that goal has been reached. Niagara has been harnessed, and man's dominion has extended from earth and sea to the air. The progress of physics and of chemistry has revolutionized man's ways and works, while the new biology has changed his mental outlook.

The greater part of this progress has taken place within the memory of those living, and the mass of scientific work has accumulated at such a rate that specialism has become inevitable. While this has the obvious advantage resulting from a division of labour, there is the penalty of a narrowed horizon, and groups of men work side by side whose language is unintelligible to each other.

Here is where the historian comes in, with two definite objects,

teaching the method by which the knowledge has been gained, the evolution of the subject, and correlating the innumerable subdivisions in a philosophy at once, in Plato's words, a science in itself as well as of other sciences. For example, the student of physics may know Crookes's tubes and their relation to Röntgen, but he cannot have a true conception of the atomic theory without a knowledge of Democritus; and the exponent of Madame Curie and of Sir J. J. Thomson will find his happiest illustrations from the writings of Lucretius. It is unfortunate that the progress of science makes useless the very works that made progress possible; and the student is too apt to think that because useless now they have never been of value.

The need of a comprehensive study of the methods of science is now widely recognized, and to recognize this need important Journals have been started, notably *Isis*, published by our Belgian colleague George Sarton, interrupted, temporarily we hope, by the war; and *Scientia*, an International Review of Scientific Synthesis published by our Italian Allies. The numerous good histories of science issued within the past few years bear witness to a real demand for a wider knowledge of the methods by which the present status has been reached. Among works from which the student may get a proper outlook on the whole question may be mentioned Dannemann's *Die Naturwissenschaften in ihrer Entwicklung und in ihrem Zusammenhange*, Bd. IV; *De la Méthode dans les Sciences*, edited by Félix Thomas (Paris: Alcan); Marvin's *Living Past*, 3rd ed. (Clarendon Press, 1917); and Libby's *Introduction to the History of Science* (Houghton Mifflin & Co., 1917).

This volume of Essays is the outcome of a quiet movement on the part of a few Oxford students to stimulate a study of the history of science. Shortly after his appointment to the Philip Walker Studentship, Dr. Charles Singer (of Magdalen College) obtained leave from Bodley's Librarian and the Curators to have a bay in the Radcliffe Camera set apart for research work in the history of science and a safe installed to hold manuscripts; and (with Mrs. Singer) offered £100 a year for five years to provide

the necessary fittings, and special books not already in the Library. The works relating to the subject have been collected in the room, the objects of which are :

First, to place at the disposal of the general student a collection that will enable him to acquire a knowledge of the development of science and scientific conceptions.

Secondly, to assist the special student in research : (a) by placing him in relationship with investigations already undertaken ; (b) by collecting information on the sources and accessibility of his material ; and (c) by providing him with facilities to work up his material.

In spite of the absence of Dr. Singer on military duty for the greater part of the time, the work has been carried on with conspicuous success, to use the words of Bodley's Librarian. Ten special students have used the room. Professor Ramsay Wright has made a study of an interesting Persian medical manuscript. Professor William Libby, of Pittsburg, during the session of 1915-16, used the room in the preparation of his admirable *History of Science* just issued. Dr. E. T. Withington, the well-known medical historian, is making a special study of the old Greek writers for the new edition of Liddell and Scott's *Dictionary*. Miss Mildred Westland has helped Dr. Singer with the Italian medical manuscripts. Mr. Reuben Levy has worked at the Arabic medical manuscripts of Moses Maimonides. Mrs. Jenkinson is engaged on a study of early medicine and magic. Dr. J. L. E. Dreyer, the distinguished historian of Astronomy, has used the room in connexion with the preparation of the *Opera Omnia* of Tycho Brahe. Miss Joan Evans is engaged upon a research on mediaeval lapidaries. Mrs. Singer has begun a study of the English medical manuscripts, with a view to a complete catalogue. How important this is may be judged from the first instalment of her work dealing with the plague manuscripts in the British Museum. With rare enthusiasm and energy Dr. Singer has himself done a great deal of valuable work, and has proved an intellectual ferment working far beyond the confines of Oxford.

I have myself found the science history room of the greatest convenience, and it is most helpful to have easy access on the shelves to a large collection of works on the subject. Had the war not interfered, we had hoped to start a *Journal of the History and Method of Science* and to organize a summer school for special students—hopes we may perhaps see realized in happier days.

Meanwhile, this volume of essays (most of which were in course of preparation when war was declared) is issued as a *ballon d'essai*.

WILLIAM OSLER.

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THE SCIENTIFIC VIEWS AND VISIONS OF SAINT HILDEGARD (1098-1180)

BY CHARLES SINGER

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I. INTRODUCTION

IN attempting to interpret the views of Hildegard on scientific subjects, certain special difficulties present themselves. First is the confusion arising from the writings to which her name has been erroneously attached. To obtain a true view of the scope of her work, it is necessary to discuss the authenticity of some of the material before us. A second difficulty is due to the receptivity of her mind, so that views and theories that she accepts in her earlier works become modified, altered, and developed in her later writings. A third difficulty, perhaps less real than the others, is the visionary and involved form in which her thoughts are cast.

But a fourth and more vital difficulty is the attitude that she adopts towards phenomena in general. To her mind there is no distinction between physical events, moral truths, and spiritual experiences. This view, which our children share with their mediaeval ancestors, was developed but not transformed by the virile power of her intellect. Her fusion of internal and external universe links Hildegard indeed to a whole series of mediaeval visionaries, culminating with Dante. In Hildegard, as in her fellow mystics, we find that ideas on Nature and Man, the Moral World and the Material Universe, the Spheres, the Winds, and the Humours, Birth and Death, and even on the Soul, the Resurrection of the Dead, and the Nature of God, are not only interdependent, but closely interwoven. Nowadays we are well accustomed to separate our ideas into categories, scientific, ethical, theological, philosophical, and so forth, and we even esteem it a virtue to retain and restrain our

thoughts within limits that we deliberately set for them. To Hildegard such classification would have been impossible and probably incomprehensible. Nor do such terms as *parallelism* or *allegory* adequately cover her view of the relation of the material and spiritual. In her mind they are really interfused, or rather they have not yet been separated.

Therefore, although in the following pages an attempt is made to estimate her scientific views, yet the writer is conscious that such a method must needs interpret her thought in a partial manner. Hildegard, indeed, presents to us scientific thought as an undifferentiated factor, and an attempt is here made to separate it by the artificial but not unscientific process of dissection from the organic matrix in which it is embedded.

The extensive literature that has risen around the life and works of Hildegard has come from the hands of writers who have shown no interest in natural knowledge, while those who have occupied themselves with the history of science have, on their side, largely neglected the period to which Hildegard belongs, allured by the richer harvest of the full scholastic age which followed. This essay is an attempt to fill in a small part of the lacuna.

II. LIFE AND WORKS

Hildegard of Bingen was born in 1098, of noble parentage, at Böckelheim, on the river Nahe, near Sponheim. Destined from an early age to a religious life, she passed nearly all her days within the walls of Benedictine houses. She was educated and commenced her career in the isolated convent of Disibodenberg, at the junction of the Nahe and the Glan, where she rose to be abbess. In 1147 she and some of her nuns migrated to a new convent on the Rupertsberg, a finely placed site, where the smoky railway junction of Bingerbrück now mars the landscape. Between the little settlement and the important mediaeval town of Bingen flowed the river Nahe, spanned by a bridge to which still clung the name of the pagan Drusus (see Fig. 1). At this spot, a place of ancient memories, secluded and yet linked to the world, our abbess passed the main portion of her life, and here she closed her eyes in the eighty-second year of her age on September 17, 1180.

Hildegard was a woman of extraordinarily active and independent mind. She was not only gifted with a thoroughly efficient intellect, but was possessed of great energy and considerable

literary power, and her writings cover a wide range, betraying the most varied activities and remarkable imaginative faculty. The best known, and in a literary sense the most valuable of her works, are the books of visions. She was before all things an ecstatic, and both her *Scivias* (1141-50) and her *Liber divinorum operum simplicis hominis* (1163-70) contain passages of real power and beauty. Less valuable, perhaps, is her third long

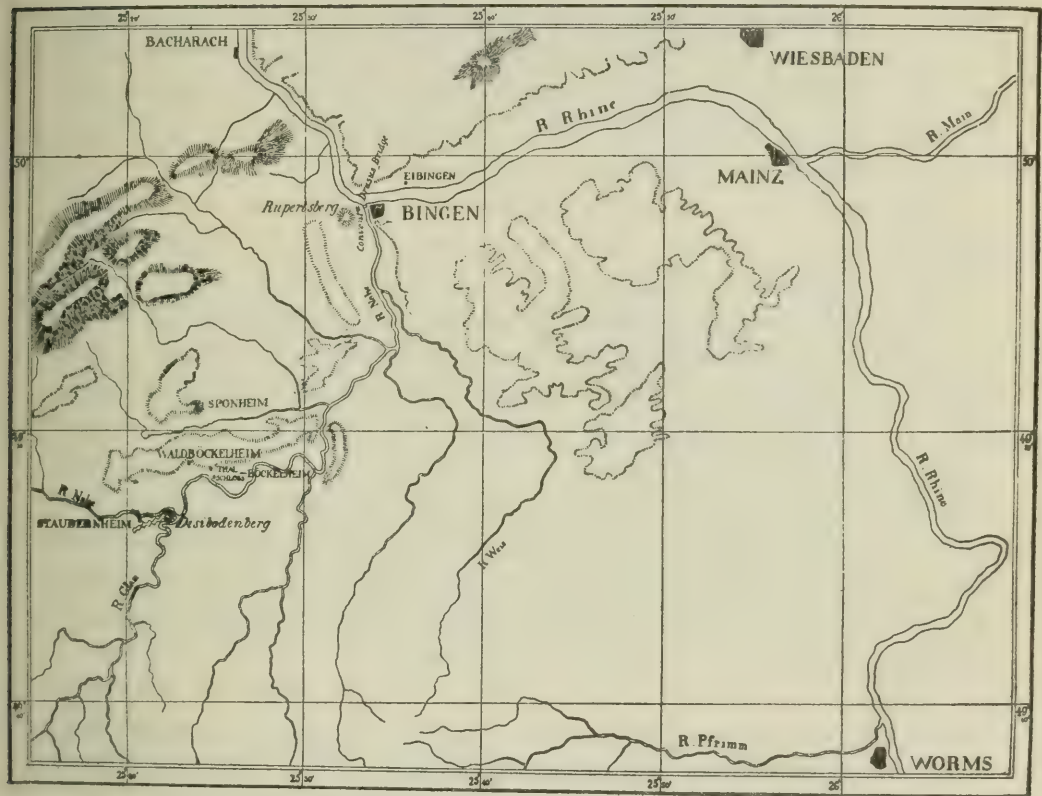


FIG. 1. THE HILDEGARD COUNTRY

mystical work (the second in point of time), the *Liber vitae meritorum* (1158-62). She is credited with the authorship of an interesting mystery-play and of a collection of musical compositions, while her life of St. Disibode, the Irish missionary (594-674) to whom her part of the Rhineland owes its Christianity, and her account of St. Rupert, a local saint commemorated in the name 'Rupertsberg', both bear witness alike to her narrative powers, her capacity for systematic arrangement, and her historical interests. Her extensive correspondence demonstrates the influence

that she wielded in her own day and country, while her *Quaestionum solutiones triginta octo*, her *Explanatio regulae sancti Benedicti*, and her *Explanatio symboli sancti Athanasii ad congregationem sororum suorum* give us glimpses of her activities as head of a religious house.

Her biographer, the monk Theodoric, records that she also busied herself with the treatment of the sick, and credits her with miraculous powers of healing.¹ Some of the cited instances of this faculty, as the curing of a love-sick maid,² are, however, but manifestations of personal ascendancy over weaker minds; notwithstanding her undoubted acquaintance with the science of her day, and the claims made for her as a pioneer of the hospital system, there is no serious evidence that her treatment extended beyond exorcism and prayer.

For her time and circumstance Hildegard had seen a fair amount of the world. Living on the Rhine, the highway of Western Germany, she was well placed for observing the traffic and activities of men. She had journeyed at least as far north as Cologne, and had traversed the eastern tributary of the great river to Frankfort on the Main and to Rothenburg on Taube.³ Her own country, the basin of the Nahe and the Glan, she knew intimately. She was, moreover, in constant communication with Mayence, the seat of the archbishopric in which Bingen was situated, and there has survived an extensive correspondence with the ecclesiastics of Cologne, Speyer, Hildesheim, Trèves, Bamberg, Prague, Nürnberg, Utrecht, and numerous other towns of Germany, the Low Countries, and Central Europe.

Hildegard's journeys, undertaken with the object of stimulating spiritual revival, were of the nature of religious progresses, but, like those of her contemporary, Bernard of Clairvaux, they were in fact largely directed against the heretical and most cruelly persecuted Cathari, an Albigensian sect widely spread in the Rhine country of the twelfth century, whom Hildegard regarded as 'worse than the Jews'.⁴ In justice to her memory it is to be

¹ *Vita Sanctae Hildegardis auctoribus Godefrido et Theodorico monachis*, lib. iii, cap. 1. The work has been frequently reprinted and is in Migne, *Patrologia Latina*, vol. 197, col. 91 ff. This volume will be quoted here simply as 'Migne'.

² Migne, col. 119.

³ The erroneous statement in some of her biographies that she journeyed to Paris is based on a misunderstanding.

⁴ Cardinal J. B. Pitra, *Analecta sacra*, vol. viii, p. 350, Paris, 1882. This volume will here be quoted simply as 'Pitra'.

Et in medio istoz elementoz .xvi
 quidam arenosus glob' pluri
 mo magnitudinis e. quem s'cta ele
 menta ita circumdant quod nec
 hac nec illac labi possit. qui manife
 ste ostendit in firmitudine creaturas
 dei hominē p'inde considerationis
 de limo terre. mirabili modo multz
 gē factum degenere. 7 uirtute erum.
 detn creaturā ita obvolutum qd
 ab eis nullomodo separari ualet. quia
 elementa mundi ad seruitutē ho
 minis creata. ipsi famulari exhibet
 dum homo uelut in medio eoz se
 det. ipsis diuina dispositione p'ideat.
 ut etiam p me insipitatus dauid dicit.
 Verba dauid ad candē p'roo.

David
 Lo x i a 7 honore coronasti eā. xvii.
 7 construxisti eum super opa
 manū tuaz. Quod dicitur. O tu

libant. sua potestate si compositione u silu
 sum ad redreptione hois misit i mundū.
 Sole eū nulla indignano sercoris postu
 it sic e n' dñm ulla p'ntat iusticie tan
 gere potit. S; in o ho i speculauit. serē
 ita bonū e mala i'priet. Et qd et eū in
 malitudine carnaliu desiderioz ser
 des. Et qd et qd clarissime gemine ur
 uū i' re fulget. p'roni angis bonū
 gressit e malu occupat unde e illud
 i more etne p'ctiosis accepit. 7 in
 morte sepult e qd bonū e abiecit.
 Bonū n' angis malū neglexerit e bonū
 amauerit casū diaboli uidetur q ueri
 tate uoletat opprimere 7 iudaciū eri
 gere. Quap' ipsi i amore di carserit
 firmū fundamētū uoz boni habentes
 ita qd aliud nolūt quā qd dō placet
 magis i laude ei celsantes. S; p'roni
 ho dñm cognouit. eū in spirititate di
 let. ac p'ceptū ei suscipiens se obediuntē

subleuari suscipiā. Et Tu aut o homo
 multo ceteris uis summa tangere. q nec
 minima comprehendere uales. Admo
 nito ad uirgines e conuertes.
 qualitē scitauit agghi debeant.
Vnde audi me t' dicent. Syme
 admonit' in abiectione seclaru
 negiorū. aut i conuertia carna
 liū. uigū mei ferrē desiderat. ante
 qm hoc aggreclians p'ronū clama
 e. in hoc p'icua querens me. Qu
 uabo te. S; si etiā admonitione mea
 tacui me uis imitari. post me respice
 ceteri i uiguitatis pudore. quā ut
 flos de ingrato agro nascit. sic e
 ego sine uirili femine narui sui. of
 tendi in agrū. animi tui i multa
 humiliatē. Alloquet me i lang
 tate uiciorū lactuarū tuarū. E
 dic. S; d's ms. Ego indigni homo n
 habeo ammentipso hanc causam

PLATE II. THE THREE SCRIPTS OF THE WIESBADEN CODEX B



INCIPIT
 SCIVIAS SV
 APPLICIS SV
 OMNIS SV

INCIPIT
 NO CAD
 RIME P
 INCIPIT

PLATE III. TITLE-PAGE OF THE HEIDELBERG CODEX
 OF THE SCIVIAS

recalled that she herself was ever against the shedding of blood, and had her less ferocious views prevailed, some more substantial relic than the groans and tears of this people had reached our time, while the annals of the Church had been spared the defilement of an inexpiable stain.

Hildegard's correspondence with St. Bernard, then preaching his crusade, with four popes, Eugenius III, Anastasius IV, Adrian IV, and Alexander III, and with the emperors Conrad and Frederic Barbarossa, brings her into the current of general European history, while she comes into some slight contact with the story of our own country by her hortatory letters to Henry II and to his consort Eleanor, the divorced wife of Louis VII.¹

To complete a sketch of her literary activities, mention should perhaps be made of a secret script and language, the *lingua ignota*, attributed to her. It is a transparent and to modern eyes a foolishly empty device that hardly merits the dignity of the term 'mystical'. It has, however, exercised the ingenuity of several writers, and has been honoured by analysis at the hands of Wilhelm Grimm.²

Ample material exists for a full biography of Hildegard, and a number of accounts of her have appeared in the vulgar tongue. Nearly all are marred by a lack of critical judgement that makes their perusal a weary task, and indeed it would need considerable skill to interest a detached reader in the minutiae of monastic disputes that undoubtedly absorbed a considerable part of her activities. Perhaps the best life of her is the earliest; it is certainly neither the least critical nor the most credulous, and is by her contemporaries, the monks Godefrid and Theodoric.³

¹ Pitra, p. 556.

² Wilhelm Grimm, 'Wiesbader Glossen', in Moriz Haupt's *Zeitschrift für deutsches Alterthum*, Leipzig, 1848, vol. vi, p. 321. The script is reproduced in the ill-arranged and irritating work of J. P. Schmelzeis, *Das Leben und Wirken der heiligen Hildegardis*, Freiburg im Breisgau, 1879; and in Pitra, p. 497. The subject has been summarized by F. W. E. Roth in his *Lieder und unbekanntes Sprache der h. Hildegardis*, Wiesbaden, 1880.

³ A short sketch of her life of yet earlier date has survived. It is from the hand of the monk Guibert and was probably written in 1180: Pitra, p. 407. The best modern account of her is by F. W. E. Roth in the *Zeitschrift für kirchliche Wissenschaft und kirchliches Leben*, vol. ix, p. 453, Leipzig, 1888. Less critical but more readable is the essay by Albert Battandier, 'Sainte Hildegarde, sa vie et ses œuvres', in the *Revue des questions historiques*, vol. xxxiii, pp. 395-425, Paris, 1883.

The title of 'saint' is usually given to Hildegard, but she was not in fact canonized. Attempts towards that end were made under Gregory IX (1237), Innocent IV (1243), and John XXII (1317). Miraculous cures and other works of wonder were claimed for her, but either they were insufficiently miraculous or insufficiently attested.¹ Those who have impartially traced her life in her documents will agree with the verdict of the Church. Hers was a fiery, a prophetic, in many ways a singularly noble spirit, but she was not a saint in any intelligible sense of the word.

III. BIBLIOGRAPHICAL NOTE

There is no complete edition of the works of Hildegard. For the majority of readers the most convenient collection will doubtless be vol. 197 of Migne, *Patrologia Latina*. This can be supplemented from Cardinal J. B. Pitra's well-edited *Analecta sacra*, the eighth volume of which contains certain otherwise inaccessible works of Hildegard,² and is the only available edition of the *Liber vitae meritorum per simplicem hominem a vivente luce revelatorum*.

Manuscripts of the writings of our abbess are numerous and are widely scattered over Europe. Four of them are of special importance for our purpose, and are here briefly described.

(A) is a vast parchment of 480 folios in the Nassauische Landesbibliothek at Wiesbaden. This much-thumbed volume, still bearing the chain that once tethered it to some monastic desk, is written in a thirteenth-century script. There is evidence that it was prepared in the neighbourhood of Hildegard's convent, if not in that convent itself. It is interesting as a collection of those works that the immediate local tradition attributed to her, and is thus useful as a standard of genuineness.³ Reference will be made to it in the following pages as the *Wiesbaden Codex A*. Its contents are as follows:

1. Liber Scivias.
2. Liber vitae meritorum.

¹ The 'Acta inquisitionis de virtutibus et miraculis sanctae Hildegardis' are reprinted in Migne, col. 131.

² This volume is supplemented by 'Annotationes ad Nova S. Hildegardis Opera' in *Analecta Bollandiana*, vol. i, p. 597, Brussels, 1882.

³ This Wiesbaden MS. has been fully described by Antonius van der Linde, *Die Handschriften der Königlichen Landesbibliothek in Wiesbaden*, Wiesbaden, 1877.

3. Liber divinorum operum.
4. Ad praelatos moguntienses.
5. Vita sanctae Hildegardis. By Godefrid and Theodoric.
6. Liber epistolarum et orationum. This collection contains 292 items, and includes the *Explanatio symboli Athanasii*, the Exposition of the Rule of St. Benedict, and the Lives of St. Disibode and St. Rupert.
7. Expositiones evangeliorum.
8. Ignota lingua and Ignotae litterae.
9. Litterae villarenses.
10. Symphonia harmoniae celestum revelationum.

(B) is also at Wiesbaden, and will be cited here as the *Wiesbaden Codex B*. It contains the *Scivias* only, and is a truly noble volume of 235 folios, beautifully illuminated, in excellent preservation, and of the highest value for the history of mediaeval art. It has been thoroughly investigated by the late Dom Louis Baillet,¹ who concluded that it was written in or near Bingen between the dates 1160 and 1180. Its miniatures help greatly in the interpretation of the visions, illustrating them often in the minutest and most unexpected details. In view of the great difficulty of visualizing much of her narrative, these miniatures afford to our mind strong evidence that the MS. was supervised by the prophetess herself, or was at least prepared under her immediate tradition. This view is confirmed by comparing the miniatures with those of the somewhat similar but inferior Heidelberg MS. (C).

Both the miniatures and the script of the Wiesbaden Codex B are the work of several hands. There are three distinct hand-writings discernible (Plate II). The earliest is attributed by Baillet in his careful work to the twelfth century, while the later writing is in thirteenth-century hands.² It thus appears to us that while Hildegard herself probably supervised the earlier stages of the preparation of this volume, its completion took place subsequent to her death. This view is sustained by the fact

¹ Louis Baillet, 'Les Miniatures du Scivias de sainte Hildegarde', in the *Monuments et Mémoires publiés par l'Académie des Inscriptions et Belles-Lettres*, Paris, 1912, especially pp. 139 and 145.

² We are inclined to place the preparation of this remarkable MS. at a slightly later date than that attributed to it by Baillet. As Wiesbaden is at present inaccessible we have reproduced the facsimiles in Plate II from Baillet's monograph.

that some of the later miniatures are far less successful than the earlier figures in aiding the interpretation of her text.

The two Wiesbaden MSS. appear to have remained at the convent on the Rupertsberg opposite Bingen until the seventeenth century. They were studied there by Trithemius in the fifteenth century, and one of them at least was seen by the Mayence Commission of 1489. Later they were noted by the theologians Osiander (1527) and Wicelius (Weitzel, 1554), and by the antiquary Nicolaus Serarius (1604). In 1632, during the Thirty Years' War, the Rupertsberg buildings were destroyed, the MSS. being removed to a place of safety in the neighbouring settlement at Eibingen, where they were again recorded in 1660 by the Jesuits Papenbroch and Henschen.¹ At some unknown date they were transferred to Wiesbaden, where they were examined in 1814 by Goethe,² and a few years later by Wilhelm Grimm,³ and where they have since remained.

(C) This MS. is at the University Library at Heidelberg. It also contains only the *Scivias*, and it is the only known illuminated MS. of that work except the Wiesbaden Codex B. The Heidelberg MS. was prepared with great care in the early thirteenth century, only a little later than its fellow, but its figures afford little aid in the interpretation of the text. Thus, for instance, the Heidelberg diagram of the universe (Plate IV) is of a fairly conventional type which quite fails to illustrate the difficult description. The obscurities of the text are, however, at once explained by a figure in the Wiesbaden Codex B (Fig. 2): we thus obtain further indirect evidence of the personal influence of Hildegard in the preparation of that MS. The representation of Hildegard in the Heidelberg MS. (Plate III) shows no resemblance to those in the Wiesbaden Codex B (Plate I) or in the Lucca MS. (Plates VI to IX), which will now be described.

(D) is an illustrated codex of the *Liber divinorum operum simplicis hominis* at the Municipal Library at Lucca. It contains ten beautiful miniatures, some of which are here reproduced (Plates VI to IX and XI), as they are of special value for the

¹ For the history of these MSS. see A. van der Linde, loc. cit., pp. 30-6.

² Goethe, 'Am Rhein, Main und Neckar', *Cotta's Jubiläums-Ausgabe*, vol. xxix, p. 258.

³ Wilhelm Grimm in M. Haupt's *Zeitschrift für deutsches Alterthum*, vi, p. 321, Leipzig, 1847.

interpretation of Hildegard's theories on the relation of macrocosm and microcosm.

This Lucca MS. was described and its text printed in 1761 by Giovanni Domenico Mansi,¹ a careful scholar, who was himself

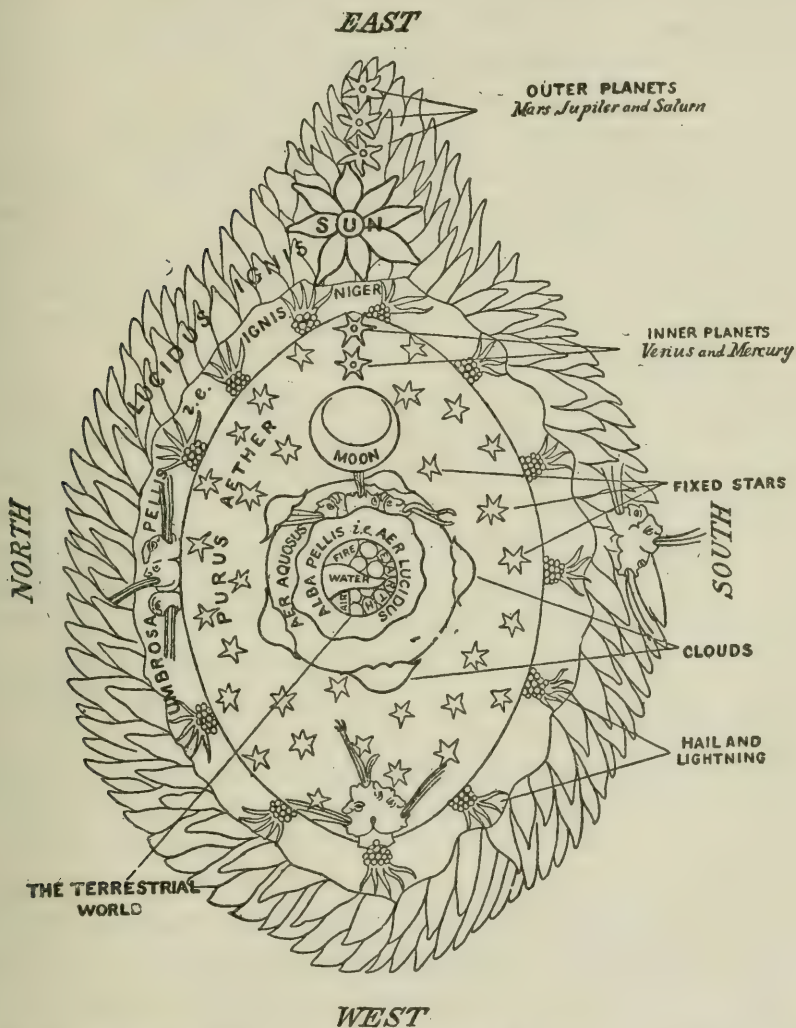


FIG. 2. HILDEGARD'S FIRST SCHEME OF THE UNIVERSE
Slightly simplified from the Wiesbaden Codex B, folio 14 r.

sometime Archbishop of Lucca. Mansi concluded that it was written at the end of the twelfth or the beginning of the

¹ In Étienne Baluze, *Miscellanea novo ordine digesta et non paucis ineditis monumentis opportunisque animadversionibus aucta opera ac studio J. D. Mansi*, 4 vols., Lucca, 1761–6; see vol. ii, p. 377,

thirteenth century. On palaeographical grounds a slightly later date would nowadays probably be preferred (Plate v b).

The work consists of ten visions, each illustrated by a figure. The date, character, and meaning of these miniatures raise special problems to which only very superficial reference can here be made. Unfortunately but little work has been done on early Italian schools of miniaturists, and it is not a subject on which any exact knowledge can yet be said to exist.¹

Of these ten miniatures we may dismiss the last five in a few words. The sixth to the tenth visions are of purely theological interest, and the miniatures illustrating them are by a different hand to the rest. They are all relatively crude products, which appear to us to resemble other Italian work of the period at which the MS. was written. We shall concentrate our attention on the first five miniatures.

The first three miniatures of the Lucca MS. (Plates VI to VIII) may be attributed to the same hand on the following grounds:

1. All have a very similar inset figure of the prophetess below the main picture.

2. The character of the principal figure of the first miniature (Plate VI) is almost identical with the curious universe-embracing double-headed figure of the second miniature (Plate VII).

3. The features and draughtsmanship of the central figure of the second miniature (Plate VII) are identical with those of the third (Plate VIII).

4. The beasts' heads arranged round the second miniature (Plate VII) are exactly reproduced in the third miniature (Plate VIII).

Now although these three miniatures are in some respects unique, they contain elements enabling us to date them with an approach to accuracy. These elements are to be found especially in the central figure of the second and third miniatures (Plates VII and VIII).

About the middle of the thirteenth century, as Venturi has shown,² there was a well-marked change in Northern Italy in the traditional representation of the form on the Cross. This change was followed with almost slavish accuracy, and the new form is well represented by a painting in the Uffizi Gallery (Plate x).

¹ Cf. J. A. Herbert, *Illuminated Manuscripts*, London, 1911, p. 160.

² A. Venturi, *Storia dell' arte italiana*, Milan, *in progress*, vol. v, p. 16.

It is this figure of Christ which is reproduced by our miniaturist. The central figure of Plates VII and VIII resembles that of the Uffizi crucifix, for instance, in the general pose of the body, in the position of the legs and of the arms, in the treatment of the abdominal musculature, in the method of outlining the muscles of the legs and of the arms, and in a minute and very constant detail by which the outline of the left side is continued with the fold of the groin, thus giving an impression of the left thigh being advanced on the right. Furthermore, the somewhat Byzantine cast of countenance of the figure can be closely paralleled from Northern Italian work of the same period. We therefore regard these first three miniatures of the Lucca MS. as dating from about the middle of the thirteenth century.

The remaining two miniatures (Plates IX and XI) offer special difficulties. Plate XI (illustrating the fifth vision) presents us with no complete human figures, except the small and probably copied inset of the prophetess below the miniature. The faces bear some resemblance to those of the last five miniatures; the wings, on the other hand, to those of the first miniature (Plate VI). It is perhaps possible that this miniature was the work of an early thirteenth-century artist, and that the wings and some other details were added by a later hand. The abnormal orientation, east to the left and south above, suggests that we have here to do with some special influence.

The most anomalous of all is, however, the beautiful fourth miniature (Plate IX). This picture has a general feeling of the early Renaissance, though it is hard to find in it any definite humanistic element. The nude female figure in the upper left quadrant is especially striking. No parallel to it is to be found in the thirteenth-century Italian miniatures that have so far been reproduced, and it appears to us difficult to date the miniature anterior to the fourteenth century at the very earliest. It is, in any event, by a different hand to the others. The rashes on the patients in the two upper and the right lower quadrants are perhaps an attempt to render the fatal 'God's tokens' of those waves of pestilence that devastated the Italian peninsula in the fourteenth century.

Whatever the date of these miniatures, however, they reproduce the meaning of the text of the *Liber divinorum operum* with a convincing certainty and sureness of touch. This work is the most

difficult of all Hildegard's mystical writings. Without the clues provided by the miniatures, many passages in it are wholly incomprehensible. It appears to us therefore by no means improbable that the traditional interpretation of Hildegard's works, thus preserved to our time by these miniatures and by them alone, may have had its origin from the mouth of the prophetess herself, perhaps through another set of miniatures that has disappeared or has not yet come to light.¹

IV. THE SPURIOUS SCIENTIFIC WORKS OF HILDEGARD

The scientific views of Hildegard are embedded in a theological setting, and are mainly encountered in the *Scivias* and the *Liber divinorum operum simplicis hominis*. To a less extent they appear occasionally in her *Epistolae* and in the *Liber vitae meritorum*.

Two works of non-theological tone and definitely scientific character have been printed in her name. One of these was recently edited under the title *Beatae Hildegardis causae et curae*.² A single MS. only of this work is known to exist, and is now deposited in the Royal Library of Copenhagen.³ It is an ill-written document of the thirteenth century, and the original work probably dates from this period. It has none of the characteristics of the acknowledged work of Hildegard, and indeed the only link with her name is the title, which is written in a hand different from that of the text (Plate v a). Nothing could be more unlike the ecstatic but well-ordered and systematic work of the prophetess of Bingen than the prosy disorder of the *Causae et curae*. Linguistically, also, it differs entirely from the typical writings of Hildegard, for it is full of Germanisms, which never interrupt the eloquence of her authentic works. Again, Hildegard's tendency to theoretical speculation, as for instance

¹ We are unable to concur with Baillet, however, that there is enough evidence to suggest that the miniaturists of the Lucca MS. had consulted the Wiesbaden illuminations. Baillet, *loc. cit.*, p. 147.

² *Hildegardis causae et curae edidit Paulus Kaiser*, Leipzig, B. G. Teubner, 1903. The MS. was brought to light by C. Jessen in the *Sitzungsberichte der kaiserl. Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse*, Band xlv, Heft 1, p. 97, Vienna, 1862. See also the same author in *Botanik in kulturhistorischer Entwicklung*, pp. 124-6, Leipzig, 1862, and in the *Anzeiger für Kunde der deutschen Vorzeit*, 1875, p. 175. An imperfect edition appeared in 1882 in Pitra, p. 468, under the title *Liber compositae medicinae de aegritudinum causis signis atque curis*.

³ Royal Library of Copenhagen, MS. Ny. Kgl. Saml., No. 90 b.



PLATE IV. THE UNIVERSE

bone indagandis cause et cause
 De mundi creatioe
Eus ante
 creationem
 mundi abs
 in nullo fuit
 et est et ipse
 lucet et splen
 dit fuit. et
 est et uita fuit. Cum ergo deus nullo
 dū faceret uoluit. illam de nichilo creat
 et in uoluntate ipsius inaccessa inua
 di erat. Nam cum uoluntas dei ad op
 randū opus se attendit. mox de ipsa
 De ipse

PLATE V a. OPENING LINES OF THE
 COPENHAGEN MS. OF THE
 CAUSAE ET CURAE

Incipit liber de uita
 et factum est in
 seruo anno de f
 quam uita ipse
 uenas et uisiones
 in quibus per quos
 quemcumque labo
 raueram. uera uero in deficientes
 uim me mibi homini dicitur
 multumque morum quam in
 me ignoranti demonstrat qui
 primus annus erodum pscium
 uisionem fuit. cum seraguna quig
 annorum esset. tunc mysteri
 foratidinis uisionem uide. ut to
 ta contemiserim. et per fragilitate
 corporis mei uide. appropiare inperire.

et sine uita facti nec per uita
 nec per quoniam hominum puerit. ta
 et per me ante perceptionem in uita
 pcedunt. quemadmodum ut ante crea
 tionem hominum ipse pscium fuit
 etiam illa que et uita. facta sunt
 puidi. Ego igitur puerit. et
 inbetilis forma. testificante homi
 ne illo. quem uelut in puerit. et
 uisionibus. meis pscia sum. et uel
 et quiescentem et inuenientem. testifi
 cante etiam eadem puella. cuius
 in superuolibus. uisionibus. mentione
 facta. quam plurimum infirmitati
 bus coniecta. manus tandem ad
 scribendum tremebunda conuertit.
 Quid dum facerem. sursum ad

PLATE V b. OPENING LINES OF THE LUCCA MS. OF THE
 LIBER DIVINORUM OPERUM SIMPLICIS HOMINIS

on the nature of the elements or on the form of the Universe, finds no place in the scrappy paragraphs of this apocryphal compilation.

A second work, of somewhat similar character, is entitled *Subtilitatum diversarumque creaturarum libri novem*. This is clearly a compilation, and numerous passages in it can be traced to such sources as Pliny, Walafrid Strabus, Marbod, Macer, the Physiologus, Isidore Hispalensis, Constantine the African, and the *Regimen Sanitatis Salerni*, only the last three of which exerted a traceable influence on the genuine works of our authoress. Nevertheless this *Liber subtilitatum* was early printed as Hildegard's work, along with a treatise attributed with as little justification to another woman writer, Trotula, one of the ladies of Salerno, whose name was also a household word in the Middle Ages, and was freely attached to medical writings with which she had little or nothing to do.¹ It is true that Hildegard's contemporary biographer, the monk Theodoric, assures us that she had written *De natura hominis et elementorum, diversarumque creaturarum*,² but there is nothing to suggest that the *Liber subtilitatum* is intended thereby.

The modern scholars Daremberg and Reuss have edited the *Liber subtilitatum* as Hildegard's composition,³ and the work attracted the attention of Virchow,⁴ but notwithstanding the

¹ *Experimentarius medicinae continens Trotulae curandarum Aegritudinum muliebrium . . . item quatuor Hildegardis de elementorum, fluminum aliquot Germaniae, metallorum, . . . herbarum, piscium & animantium terrae, naturis et operationibus*. Edited by G. Kraut, Strasbourg, J. Schott, 1544. The work often ascribed to Trotula is somewhat similar to the spurious medical works of Hildegard. Like them, it was probably written early in the thirteenth century. Trotula herself lived in the eleventh century, a generation or two before Hildegard. On Trotula see Salvatore de Renzi, *Collectio Salernitana*, vol. i, p. 149, Naples, 1852.

² In the *Vita*, lib. ii, cap. 1; Migne, col. 101.

³ Migne, col. 1125. See also F. A. Reuss, *De Libris physicis S. Hildegardis commentatio historico-medica*, Würzburg, 1835, and 'Der heiligen Hildegard Subtilitatum diversarum naturarum creaturarum libri novem, die werthvollste Urkunde deutscher Natur- und Heilkunde aus dem Mittelalter' in the *Annalen des Vereins für Nassauische Alterthumskunde und Geschichtsforschung*, Band vi, Heft 1, Wiesbaden, 1859.

⁴ Rudolf Virchow, 'Zur Geschichte des Aussatzes und der Spitäler, besonders in Deutschland', in Virchow's *Archiv für Pathologie*, vol. xviii, p. 285, &c., Berlin, 1860.

authority of these names, the objections which apply to the genuineness of the *Causae et curae* are also valid here :

(a) The *Liber subtilitatum* is not included in the Wiesbaden Codex A.

(b) The phrase *De natura hominis et elementorum diversarumque creaturarum*, used by Theodoric as a description and by Reuss as a title,¹ would lead one to expect great emphasis on the nature of the elements and their entry into the human frame. Such emphasis is not, in fact, discoverable in the *Liber subtilitatum*, which, moreover, does not treat of human anatomy or physiology.

(c) On the other hand, the genuine *Liber divinorum operum simplicis hominis* does lay stress on these points. This is possibly therefore the work to which Theodoric refers, and to it his description certainly applies well.

(d) As in the *Causae et curae*, there are linguistic difficulties that prevent us attributing the *Liber subtilitatum* to Hildegard. Such, for instance, is the number of Germanisms as well as the marked difference from the style and method of her acknowledged work.

(e) There are statements in the *Liber subtilitatum* that can scarcely be attributed to our authoress. Having largely explored the Rhine basin, and corresponding constantly with writers beyond the Alps, how could she possibly derive all rivers, Rhine and Danube, Meuse and Moselle, Nahe and Glan, from the same lake (of Constance) as does the author of the *Liber subtilitatum* ?²

(f) Furthermore, although that spurious work has a chapter *De elementis*, it reveals none of Hildegard's most peculiar and definite views as to their nature, origin, and fate,³ nor does it refer to the sphericity of the earth, to the vascular system of man, to

¹ Reuss, in Migne, cols. 1121 and 1122, states on Theodoric's authority that Hildegard had written a *book* on this subject : ' Exstat inter libros virginis fatidicae superstites opus argumenti partim physici partim medici, " De natura hominis, elementorum diversarumque creaturarum " in quo, ut Theodoricus idem fusius exponit, secreta naturae prophetico spiritu manifestavit.' But Theodoric does not in fact anywhere speak of a *special work* with this title or of this character. What he does write is as follows (*Vita*, lib. ii, cap. i, Migne, col. 101) : ' Igitur beata virgo . . . librum visionum . . . consummavit et *quaedam* de natura hominis et elementorum, diversarumque creaturarum, et quomodo homini ex his succurrendum sit, aliaque multa secreta prophetico spiritu manifestavit.'

² Migne, cols. 1212 and 1213.

³ As detailed in the *Liber vitae meritorum*, Pitra, p. 228, and in many places in the *Liber divinorum operum* and *Scivias*.

the humours and their relation to the winds and the elements, or to a dozen other points on which, as we shall see, Hildegard had views of her own.

Before leaving the subject of Hildegard's apocryphal works, brief reference may be made to the *Speculum futurorum temporum*, a spurious production to which her name is often attached. It exists in innumerable MSS., and has been frequently edited and translated. It is the work of Gebeno, prior of Eberbach, who wrote it in 1220, claiming that he extracted it from Hildegard's writings. Another work erroneously attributed to Hildegard is entitled *Revelatio de fratribus quatuor mendicantium ordinum*, and is directed against the four mendicant orders—Franciscans, Dominicans, Carmelites, and Augustinians. It also has been printed, but is wholly spurious, and was probably composed towards the latter part of the thirteenth century.

V. SOURCES OF HILDEGARD'S SCIENTIFIC KNOWLEDGE

In the works of Hildegard we are dealing with the products of a peculiarly original intellect, and her imaginative power and mystical tendency make an exhaustive search into the origin of her ideas by no means an easy task. With her theological standpoint, as such, we are not here concerned, and unfortunately she does not herself refer to any of her sources other than the Biblical books; to have cited profane writers would indeed have involved the abandonment of her claim that her knowledge was derived by immediate inspiration from on high. Nevertheless it is possible to form some idea, on internal evidence, of the origin of many of her scientific conceptions.

The most striking point concerning the sources of Hildegard is negative. There is no German linguistic element distinguishable in her writings, and they show little or no trace of native German folk-lore.¹ It is true that Trithemius of Sponheim (1462-1516), who is often a very inaccurate chronicler, tells us that Hildegard 'composed works in German as well as in Latin, although she had neither learned nor used the latter tongue except for

¹ An exception must be made for the *lingua ignota*, which is presumably hers. The absence of Germanisms in her other writings may be partly due to the work of an editor. See the *Vita* by Theodorie, Migne, col. 101. Also the birth scene (see chapter ix below) is perhaps adapted from a German folk-tale.

simple psalmody'.¹ But with the testimony before us of the writings themselves and of her skilful use of Latin, the statement of Trithemius and even the hints of Hildegard² may be safely discounted and set down to the wish to magnify the element of inspiration.³ So far from her having been illiterate, we shall show that the structure and details of her works betray a considerable degree of learning and much painstaking study of the works of others. Thus, for instance, she skilfully manipulates the Hippocratic doctrines of miasma and the humours, and elaborates a theory of the interrelation of the two which, though developed on a plan of her own, is yet clearly borrowed in its broad outline from such a writer as Isidore of Seville. Again, as we shall see, some of her ideas on anatomy seem to have been derived from Constantine the African, who belonged to the Benedictine monastery of Monte Cassino.⁴

¹ Johannes Trithemius, *Chronicon insigne Monasterii Hirsaugensis, Ordinis St. Benedicti*, Basel, 1559, p. 174.

² Migne, col. 384.

³ It is not enough to suppose with some of her biographers that the visions were dictated by Hildegard and were latinized by a secretary. The visions imply a good deal of study and considerable book-learning. Among many reasons for believing that she had a very serviceable knowledge of Latin are the following :

(a) She was well acquainted with the Biblical writings and quotes them aptly and frequently.

(b) She was regarded by her contemporaries as an authority on scriptural interpretation and on Church discipline, and was frequently consulted by them on these subjects.

(c) She pleaded in person before clerical tribunals.

(d) One of the least remarkable and most credible of her 'miracles', the expounding of certain letters found upon an altar-cloth (Migne, col. 121), depends entirely on a knowledge of Latin.

(e) In the *Liber divinorum operum* (Migne, col. 922) she writes 'firmamentum celum nominavit quoniam omnia excellit', a derivation taken from Isidore and incomprehensible to one ignorant of Latin. There are many other passages in her works in which the sense depends on the Latin usage of a word.

(f) No mention of this ignorance is made by Guibert in the short sketch of her life that he wrote almost immediately after her death (1180; see Pitra, p. 407). On the contrary, he suggests that she had been an industrious student.

(g) The *Liber divinorum operum* may especially be pointed out among her works as betraying a very considerable degree of learning. Notably her elaborate doctrine of the macrocosm and microcosm must have involved extensive reading.

The general question of Hildegard's knowledge of Latin has also been discussed by Pitra and by Albert Battandier in the *Revue des questions historiques*, vol. xxxiii, p. 395, Paris, 1883.

⁴ See chapter viii.

Hildegard lived at rather too early a date to drink from the broad stream of new knowledge that was soon to flow into Europe through Paris from its reservoir in Moslem Spain. Such drops from that source as may have reached her must have trickled in either from the earlier Italian translators or from the Jews who had settled in the Upper Rhineland, for it is very unlikely that she was influenced by the earlier twelfth-century translations of Averroes, Avicenna, Avicbron, and Avempace, that passed into France from the Jews of Marseilles, Montpellier, and Andalusia.¹ Her intellectual field was thus far more patristic than would have been the case had her life-course been even a quarter of a century later.

(Her science is primarily of the usual degenerate Greek type, disintegrated fragments of Aristotle and Galen coloured and altered by the customary mediaeval attempts to bring theory into line with scriptural phraseology,) though a high degree of independence is obtained by the visionary form in which her views are set. She exhibits, like all mediaeval writers on science, the Aristotelian theory of the elements, but her statement of the doctrine is illuminated by flashes of her own thoughts and is coloured by suggestions from St. Augustine, Isidore Hispalensis, Bernard Sylvestris of Tours, and perhaps from writings attributed to Boethius.

The translator Gerard of Cremona (1114-87) was her contemporary, and his labours made available for western readers a number of scientific works which had previously circulated only among Arabic-speaking peoples.² Several of these works, notably Ptolemy's *Almagest*, Messahalal's *De Orbe*, and the Aristotelian *De Caelo et Mundo*, contain material on the form of the universe and on the nature of the elements, and some of them probably reached the Rhineland in time to be used by Hildegard. The

¹ It is, however, just possible that she had consulted the astrological work that had been translated from the Arabic by Hermann the Dalmatian for Bernard Sylvestris, and is represented in the Bodleian MSS. Digby 46 and Ashmole 304.

² See Baldassare Boncompagni, *Della vita e delle opere di Gherardo Cremonese, Traduttore del secolo duodecimo, e di Gherardo di Sabbionetta, Astronomo del secolo decimoterzo*, Rome, 1851; also K. Sudhoff, 'Die kurze "Vita" und das Verzeichnis der Arbeiten Gerhards von Cremona, von seinen Schülern und Studien-genossen kurz nach dem Tode des Meisters (1187) zu Toledo verfasst', in *Archiv für Geschichte der Medizin*, Bd. viii, p. 73, November 1914.

Almagest, however, was not translated until 1175, and was thus inaccessible to Hildegard.¹ Moreover, as she never uses an Arabic medical term, it is reasonably certain that she did not consult Gerard's translation of Avicenna, which is crowded with Arabisms.

On the other hand, the influence of the Salernitan school may be discerned in several of her scientific ideas. The *Regimen Sanitatis* of Salerno, written about 1101, was rapidly diffused throughout Europe, and must have reached the Rhineland at least a generation before the *Liber Divinorum Operum* was composed. This cycle of verses may well have reinforced some of her microcosmic ideas,² and suggested also her views on the generation of man,³ on the effects of wind on health,⁴ and on the influence of the stars.⁵

On the subject of the form of the earth Hildegard expressed herself definitely as a spherist,⁶ a point of view more widely accepted in the earlier Middle Ages than is perhaps generally supposed. She considers in the usual mediaeval fashion that this globe is surrounded by celestial spheres that influence terrestrial events.⁷ But while she claims that human affairs, and especially human diseases, are controlled, under God, by the heavenly cosmos, she yet commits herself to none of that more detailed astrological doctrine that was developing in her time, and came to efflorescence in the following centuries. In this respect she follows the earlier and somewhat more scientific spirit of such writers as Messahalāh, rather than the wilder theories of her own age. The shortness and simplicity of Messahalāh's tract on the sphere made it very popular. It was probably one of the earliest to be translated into Latin; and its contents would account for

¹ Another translation of the *Almagest* was made in Sicily in 1160, direct from the Greek. See C. H. Haskins and D. P. Lockwood, 'The Sicilian Translators of the Twelfth Century and the First Latin Version of Ptolemy's *Almagest*', in *Harvard Studies in Classical Philology*, xi. 75, Cambridge, Mass., 1910. It is wholly improbable that Hildegard had access to this rendering, which is only known from a single MS. of the fourteenth century.

² De Renzi, *Collectio Salernitana*, vol. i, p. 485, and vol. v, p. 50.

³ De Renzi, i. 486 and 495; v. 51 and 70.

⁴ De Renzi, i. 446; v. 3.

⁵ De Renzi, i. 485-6; v. 50-2.

⁶ *Scivias*, Migne, col. 403, and *Liber Divinorum Operum*, Migne, col. 868 and elsewhere.

⁷ *Scivias*, Migne, col. 404, and throughout the *Liber Divinorum Operum*.

the change which, as we shall see, came over Hildegard's scientific views in her later years.

The general conception of the universe as a series of concentric elemental spheres had certainly penetrated to Western Europe centuries before Hildegard's time. Nevertheless the prophetess presents it to her audience as a new and striking revelation. We may thus suppose that translations of Messahalāh, or of whatever other work she drew upon for the purpose, did not reach the Upper Rhineland, or rather did not become accepted by the circles in which Hildegard moved, until about the decade 1141–50, during which she was occupied in the composition of her *Scivias*.

There is another cosmic theory, the advent of which to her country, or at least to her circle, can be approximately dated from her work. Hildegard exhibits in a pronounced but peculiar and original form the doctrine of the macrocosm and microcosm. Hardly distinguishable in the *Scivias* (1141–50), it appears definitely in the *Liber Vitae Meritorum* (1158–62),¹ in which work, however, it takes no very prominent place, and is largely overlaid and concealed by other lines of thought. But in the *Liber Divinorum Operum* (1163–70) this belief is the main theme. The book is indeed an elaborate attempt to demonstrate a similarity and relationship between the nature of the Godhead, the constitution of the universe, and the structure of man, and it thus forms a valuable compendium of the science of the day viewed from the standpoint of this theory.

From whence did she derive the theory of macrocosm and microcosm? In outline its elements were easily accessible to her in Isidore's *De Rerum Natura* as well as in the Salernitan poems. But the work of Bernard Sylvestris of Tours, *De mundi universitate sive megacosmus et microcosmus*,² corresponds so closely both in form, in spirit, and sometimes even in phraseology, to the *Liber Divinorum Operum* that it appears to us certain that Hildegard must have had access to it also. Bernard's work can be dated

¹ Pitra, pp. 8, 114–16, 156, and 216.

² The work of Bernard Sylvestris has been printed by C. S. Barach and J. Wrobel, Innsbruck, 1876. His identity, his sources, and his views are discussed by Charles Jourdain, *Dissertation sur l'état de la philosophie naturelle . . . pendant la première moitié du XII^e siècle*; by A. Clerval, *Les Écoles de Chartres au Moyen Âge*, Paris, 1895, p. 259, &c.; by R. L. Poole, *Illustrations of the History of Mediaeval Thought*, London, 1884, p. 116, &c.; and by J. E. Sandys, *History of Classical Scholarship*, Cambridge, 1903, vol. i, p. 513, &c.

between the years 1145–53 from his reference to the papacy of Eugenius III. This would correspond well with the appearance of his doctrines in the *Liber Vitae Meritorum* (1158–62) and their full development in the *Liber Divinorum Operum* (1163–70).

Another contemporary writer with whom Hildegard presents points of contact is Hugh of St. Victor (1095–1141).¹ In his writings the doctrine of the relation of macrocosm and microcosm is more veiled than with Bernard Sylvestris. Nevertheless, his symbolic universe is on the lines of Hildegard's belief, and the plan of his *De arca Noe mystica* presents many parallels both to the *Scivias* and to the *Liber Divinorum Operum*. If these do not owe anything directly to Hugh, they are at least products of the same mystical movement as were his works.

We may also recall that at Hildegard's date very complex cabalistic systems involving the doctrine of macrocosm and microcosm were being elaborated by the Jews, and that she lived in a district where Rabbinic mysticism specially flourished.² Benjamin of Tudela, who visited Bingen during Hildegard's lifetime, tells us that he found there a congregation of his people. Since we know, moreover, that she was familiar with the Jews,³ it is possible that she may have derived some of the very complex macrocosmic conceptions with which her last work is crowded from local Jewish students.

The Alsatian Herrade de Landsberg (died 1195), a contemporary of Hildegard, developed the microcosm theory along lines similar to those of our abbess, and it is probable that the theory, in the form in which these writers present it, reached the Upper Rhineland somewhere about the middle or latter half of the twelfth century.

Apart from the Biblical books, the work which made the deepest impression on Hildegard was probably Augustine's *De Civitate Dei*, which seems to form the background of a large part of the *Scivias*. The books of Ezekiel and of Daniel, the Gospel of Nicodemus, the Shepherd of Hermas, and the Apocalypse, all contain a lurid type of vision which her own spiritual experiences

¹ The works of Hugh of St. Victor are published in Migne, *Patrologia Latina*, clxxv–clxxvii.

² The Kalonymos family furnished prominent examples.

³ Charles Singer, 'Allegorical Representation of the Synagogue, in a Twelfth-Century Illuminated MS. of Hildegard of Bingen', *Jewish Quarterly Review*, new series, vol. v, p. 268, Philadelphia, 1915. For further evidence of Hildegard's acquaintance with the Jews see Pitra, p. 216; and Migne, cols. 967 and 1020–36.



PLATE VI. NOUS PERVADED BY THE GODHEAD AND
CONTROLLING HYLE



PLATE VII. NOUS PERVADED BY THE GODHEAD EMBRACING THE MACROCOSM WITH THE MICROCOSM

would enable her to utilize, and which fit in well with her microcosmic doctrines. Ideas on the harmony and disharmony of the elements she may have picked up from such works as the Wisdom of Solomon and the Pauline writings, though it is obvious that Isidore of Seville and the *Regimen Sanitatis Salerni* were also drawn upon by her.

Her figure of the Church in the *Scivias* reminds us irresistibly of Boethius' vision of the gracious feminine form of Philosophy. Again, the visions of the punishments of Hell which Hildegard recounts in the *Liber Vitae Meritorum*¹ bear resemblance to the work of her contemporary Benedictine, the monk Alberic the younger of Monte Cassino, to whom Dante also became indebted.²

Hildegard repeatedly assures us that most of her knowledge was revealed to her in waking visions. Some of these we shall seek to show had a pathological basis, probably of a migrainous character, and she was a sufferer from a condition that would nowadays probably be classified as hystero-epilepsy. Too much stress, however, can easily be laid on the ecstatic presentment of her scientific views. Visions, it must be remembered, were 'the fashion' at the period, and were a common literary device. Her contemporary Benedictine sister, Elizabeth of Schönau, as well as numerous successors, as for example Gertrude of Robersdorf, adopted the same mechanism. The use of the vision for this purpose remained popular for centuries, and we may say of these writers, as Ampère says of Dante, that 'the visions gave not the genius nor the poetic inspiration, but the form merely in which they were realized'.

The contemporaries of Hildegard who provide the closest analogy to her are Elizabeth of Schönau (died 1165), whose visions are recounted in her life by Eckbertus;³ and Herrade de Landsberg, Abbess of Hohenburg in Alsace, the priceless MS. of whose *Hortus Deliciarum* was destroyed by the Germans in the siege of Strasbourg in 1870.⁴ With Elizabeth of Schönau,

¹ Pitra, p. 51 et seq.

² Catello de Vivo, *La Visione di Alberico, ristampata, tradotta e comparata con la Divina Commedia*, Ariano, 1899. For a comparison of Dante's visions and those of Hildegard see Albert Battandier in the *Revue des questions historiques*, vol. xxxiii, p. 422, Paris, 1883.

³ Reprinted in Migne, vol. 195.

⁴ Herrade de Landsberg, *Hortus Deliciarum*, by A. Straub and G. Keller, Strasbourg, 1901, with two supplements.

who lived in her neighbourhood, Hildegard was in frequent correspondence. With Herrade she had, so far as is known, no direct communication; but the two were contemporary, lived not very far apart, and under similar political and cultural conditions. Elizabeth's visions present some striking analogies to those of Hildegard, while the figures of Herrade, of which copies have fortunately survived, often suggest the illustrations of the Wiesbaden or of the Lucca MSS.

VI. THE STRUCTURE OF THE MATERIAL UNIVERSE

To the student of the history of science, Hildegard's beliefs as to the nature and structure of the universe are among the most interesting that she has to impart. Her earlier theories are in some respects unique among mediaeval writers, and we possess in the Wiesbaden Codex B a diagram enabling us to interpret her views with a definiteness and certainty that would otherwise be impossible.

Hildegard's universe is geocentric, and consists of a spherical earth,¹ around which are arranged a number of concentric shells or zones. The inner zones are spherical, the outer oval, and the outermost of all egg-shaped, with one end prolonged and more pointed than the other (Fig. 2). The concentric structure is a commonplace of mediaeval science, and is encountered, for instance, in the works of Bede, Isidore, Alexander of Neckam, Roger Bacon, Albertus Magnus, and Dante. To all these writers, however, the universe is spherical. The egg-shape is peculiar to Hildegard. Many of the *Mappaemundi* of the Beatus and other types exhibit the *surface* of the habitable earth itself as oval, and it was from such charts that Hildegard probably gained her conception of an oval universe. In her method of orientation also she follows these maps, placing the east at the top of the page where we are accustomed to place the north.²

It is unfortunate that she does not deal with geography in the restricted sense, and so we are not in full possession of her views on the antipodes, a subject of frequent derision to patristic and of misconception to scholastic writers. She does, however, vaguely

¹ For sphericity of earth see especially Migne, cols. 868 and 903.

² In her later *Liber Divinorum Simplicis Hominis* this method of orientation is varied both in the text and also in the Lucca illustrations.

refer to the inversion of seasons and climates in the opposite hemisphere,¹ though she confuses the issue by the adoption of a theory widespread in the Middle Ages and reproduced in the *Divina Commedia*, that the antipodean surface of the earth is uninhabitable, since it is either beneath the ocean or in the mouth of the Dragon² (Plate XI, cp. Fig. 4). The nature of the antipodean inversion of climates was clearly grasped by her contemporary, Herrade de Landsberg (Fig. 5).

Hildegard's views as to the internal structure of the terrestrial sphere are also somewhat difficult to follow. Her obscure and confused doctrine of Purgatory and Hell has puzzled other writers besides ourselves,³ nor need we consider it here, but she held that the interior of the earth contained two vast spaces shaped like truncated cones, where punishment was meted out and whence many evil things had issue.⁴ Her whole scheme presents analogies as well as contrasts to that of her kindred spirit Dante.⁵ Hildegard, however, who died before the thirteenth century had dawned, presents us with a scheme far less definite and elaborated than that of her great successor, who had all the stores of the golden age of scholasticism on which to draw.

In Hildegard's first diagram of the universe, which is of the nature of an 'optical section', the world, the *sphaera elementorum* of Johannes Sacro Bosco and other mediaeval writers, is diagrammatically represented as compounded of earth, air, fire, and water confusedly mixed in what her younger contemporary, Alexander of Neckam (1157–1217), calls 'a certain concordant discord of the elements'. In the illustrations to the Wiesbaden Codex B the four elements have each a conventional method of representation, which appears again and again in the different miniatures (Fig. 2 and Plates XII and XIII).

Around this world with its four elements is spread the atmosphere, the *aer lucidus* or *alba pellis*, diagrammatically represented, like the earth which it enwraps, as circular. Through this *alba pellis* no creature of earth can penetrate. Beyond are

¹ Migne, col. 906.

² Migne, cols. 903–4.

³ See H. Osborn Taylor, *The Mediaeval Mind*, vol. i, p. 472, London, 1911.

⁴ Migne, cols. 904–6.

⁵ H. Osborn Taylor, *The Mediaeval Mind*, i. 468, 471; ii. 569. See also A. Battandier, *Revue des questions historiques*, vol. xxxiii, p. 422, Paris, 1883

ranged in order four further shells or zones. Each zone contains one of the cardinal winds, and each cardinal wind is accompanied by two accessory winds, represented in the traditional fashion by the breath of supernatural beings.

Of the four outer zones the first is the *aer aquosus*, also round, from which blows the east wind. In the outer part of the *aer aquosus* float the clouds, and according as they contract or expand or are blown aside, the heavenly bodies above are revealed or concealed.

Enwrapping the *aer aquosus* is the *purus aether*, the widest of all the zones. The long axis of this, as of the remaining outer shells, is in the direction from east to west, thus determining the path of movement of the heavenly bodies. Scattered through the *purus aether* are the constellations of the fixed stars, and arranged along the long axis are the moon and the two inner planets. From this zone blows the west wind. The position and constitution of this *purus aether* is evidently the result of some misinterpretation of Aristotelian writings.

The next zone, the *umbrosa pellis* or *ignis niger*, is a narrow dark shell, whence proceed the more dramatic meteorological events. Here, following on the hints of the Wisdom of Solomon (chap. v) and the Book of Job (chap. xxxviii), are situated the diagrammatically portrayed treasuries of lightning and of hail. From here the tempestuous north wind bursts forth. This *ignis niger* is clearly comparable to the *dry earthy exhalation* that works of the Peripatetic school regard as given off by the outer fiery zone. The presence of the *ignis niger* thus suggests some contact on the part of the authoress with the teaching of the *Meteorologica* of Aristotle.¹

The outermost layer of all is a mass of flames, the *lucidus ignis*. Here are the sun and the three outer planets, and from here the south wind pours its scorching breath (Fig. 2).

The movements of the four outer zones around each other, carrying the heavenly bodies with them, are attributed to the

¹ The *Meteorologica* had been translated about 1150 by Aristippus, the minister of William the Bad of Sicily. The version of Aristippus passed quickly into circulation (Valentine Rose, 'Die Lücke im Diogenes Laërtus und der alte Übersetzer' in *Hermes*, i. 376, Berlin, 1866), but hardly soon enough for Hildegard's *Scivias*, which was completed about 1150. It is, of course, possible that the references to the *ignis niger* are later interpolations, but this is very unlikely in view of the way in which she speaks of this vision in the *Liber Divinorum Operum*.

winds in each zone. The seasonal variations in the movements of the heavenly bodies, along with the recurring seasons themselves, are also determined by the prevalent winds, which, acting as the motive power upon the various zones, form a celestial parallelogram of forces. In this way is ingeniously explained also why in spring the days lengthen and in autumn they shorten until in either case an equinox is reached (Fig. 2).

‘ I looked and behold the east and the south wind with their collaterals, moving the firmament by the power of their breath, caused it to revolve over the earth from east to west ; and in the same way the west and north winds and their collaterals, receiving the impulse and projecting their blast, thrust it back again from west to east. . . .

‘ I saw also that as the days began to lengthen, the south wind and his collaterals gradually raised the firmament in the southern zone upwards towards the north, until the days ceased to grow longer. Then when the days began to shorten, the north wind with his collaterals, shrinking from the brightness of the sun, drove the firmament back gradually southward until by reason of the lengthening days the south wind began yet again to raise it up ’ ¹ (Plates VII and VIII).

Intimately bound up not only with her theory of the nature and structure of the universe but also with her eschatological beliefs is Hildegard’s doctrine of the elements. Before the fall of man these were arranged in a harmony,² which was disturbed by that catastrophe (Plate XII *a*),³ so that they have since remained in the state of mingled confusion in which we always encounter them on the terrestrial globe. This *mistio*, to use the mediaeval Aristotelian term, is symbolized by the irregular manner in which the elements are represented in the central sphere of the diagram of the universe (Fig. 2). Thus mingled they will remain until subjected to the melting-pot of the Last

¹ Migne, cols. 789-91.

² Migne, col. 389.

³ Plate XII *a*. The elements are represented in their original order undisturbed by the Fall. Uppermost is the *purus aether* or *aer lucidus* containing the stars and representing the element *air* in Hildegard’s cosmic system. Next comes *water*. Below, and to the left, is a dark mass separating into tongues, one of which is formed into a serpent’s head. These tongues are flames of *fire*. Below, and to the right, are plants and flowers emblematical of *earth*. The serpent, the enemy, vomits over a cloud of stars (signifying the fallen angels) that are borne downward by the falling Adam. In the four corners of the miniature the symbols of the elements are again displayed.

Judgement (Plate XIII),¹ when they will emerge in a new and eternal harmony, no longer mixed as matter, but separate and pure, parts of the new heaven and the new earth (Plate XII *b*).²

‘ But the heavens and the earth, which are now, . . . are kept in store and reserved unto fire against the day of judgment and perdition of ungodly men. . . . But the day of the Lord will come . . . in the which the heavens shall pass away with a great noise, and the elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up. . . . Nevertheless we, according to his promise, look for new heavens and a new earth, wherein dwelleth righteousness’ (2 Peter iii. 7, 10, and 13).

So Hildegard, acting on a scriptural hint, is enabled to dematerialize her doctrine of the after-things.

But although since man’s fall the elements have lost their order and their harmony on this terrestrial orb, yet is that harmony still in part preserved in the celestial spheres that encircle and surround our globe; and water, air, earth, and fire have each their respective representatives in the four concentric zones, the *aer aquosus*, the *purus aether*, the *umbrosa pellis*, and the *lucidus ignis* (Fig. 2). These are the ‘superior elements’ which still retain some at least of their individuality and primal purity. From each of their spheres blows, as we have seen, one of the cardinal winds, and each wind partakes of the elemental character of the zone whence it issues, and has a corresponding influence

¹ Plate XIII. Above, in a circle, sits the Heavenly Judge. He is flanked on either side by groups of angels bearing the cross and other symbols. The lower circle exhibits the final destruction of the elemental Universe. The four winds and their collaterals are here subjecting the elements to the crucible heat of their combined blasts. Strewn among the elements can be seen men, plants, and animals. Between the circles is an angel sounding the last trump, and holding the recording roll of good and evil deeds. He faces the throng of the righteous who are rising from their bones, while he turns his back on the weeping crowd of those doomed to torment. Below these latter crouches Satan, now enchained.

² Plate XII *b*. In the highest circle is the Trinity flanked to the left by the Virgin and to the right by the Baptist, with Cherubim below. In the middle circle are two groups, the Saints above and the Prophets and Apostles below. In the lowest circle are the elements, now rearranged in their eternal harmony; uppermost of these is the *purus aether* now separated from the *aer lucidus* and containing the stars; on either side are light-coloured flame-like processes representing the *air*; below the aether is *water*, indicated by a zone of undulating lines; then comes the *earth* symbolized, as usual, by a group of plants. Below and to the side of *earth* are dark-coloured flames of fire, now controlled and confined to this lowest rung.

on man's body, since each of the four humours is specifically affected by the element to which it corresponds.

'Then I saw that by the diverse quality of the winds, and of the atmosphere as they in turn sweep through it, the humours in man are agitated and altered. For in each of the superior elements there is a breath of corresponding quality by which, through the power of the winds, the corresponding element [below] is forced to revolve in the atmosphere, and in no other way is it moved. And by one of those winds, with the agency of sun, moon, and stars, the atmosphere which tempers the world is breathed forth'¹ (Plate VII).

This doctrine of the relation of the various winds to the four elements and through them to the four humours is found in the *De Rerum Natura* of Isidore of Seville, and is occasionally illustrated in European MSS. from the ninth century onward,² but we meet it set forth with special definiteness in the twelfth century in the translations from Messahalāh. It is encountered also in the work of Herrade de Landsberg. In and after the thirteenth century it had become a commonplace.

The description we have given of the universe was in the main set forth by Hildegard in her first work, the *Scivias* (1141–50).³ Subsequently she became dissatisfied with the account she had given, and while not withdrawing it, she sought in the *Liber Divinorum Operum* (1163–70) so to modify the original presentment as to bring it more into line with accepted views. Thus she writes: 'There appeared to me in vision a *disk* very like that object which I saw twenty-eight years ago of the form of an *egg*, in the third vision of my book *Scivias*. In the outer part of the disk there was as it were the *lucidus ignis*, and beneath it the circle of the *ignis niger* was portrayed . . . and these two circles were so joined as to be one circle.' There was thus one outer zone representing the fire. 'Under the circle of the *ignis niger* there was another circle in the likeness of the *purus aether* which was of the same width as the two conjoined [outer] fiery circles. And below this circle again was the circle of the *aer aquosus* as wide as the *lucidus ignis*. And below this circle was yet another

¹ Migne, col. 791.

² See Ernest Wickersheimer, 'Figures médico-astrologiques des neuvième, dixième et onzième siècles', in the *Transactions of the Seventeenth International Congress of Medicine, Section XXIII, History of Medicine*, p. 313, London, 1913.

³ Migne, cols. 403–14.

circle, the *fortis et albus lucidusque aer* . . . the width whereof was as the width of the *ignis niger*, and these circles were joined to make one circle which was thus again of width equal to the outer two. Again, under this last circle yet another circle, the *aer tenuis*, was distinguishable, which could be seen to raise itself as a cloud, sometimes high and light, sometimes depressed and dark, and to diffuse itself as it were throughout the whole disk. . . . The outermost fiery circle perfuses the other circles with its fire, while the watery circle saturates them with its moisture. [cp. Wisdom of Solomon, xix. 18–20]. And from the extreme eastern part of the disk to the extreme west a line is stretched out [i. e. the equator] which separates the northern zones from the others' ¹ (see Fig. 3 and Plates VII and VIII).

The earth lies concentrically with the *aer tenuis*, and its measurements are given thus: 'In the midst of the *aer tenuis* a globe was indicated, the circumference of which was everywhere equidistant from the *fortis et albus lucidusque aer*, and it was as far across as the depth of the space from the top of the highest circle to the extremity of the clouds, or from the extremity of the clouds to the circumference of the inner globe' ¹ (Fig. 3).

In her earlier work, the *Scivias*, Hildegard had not apparently realized the need of accounting for the independent movements of the planets other than the sun and moon. She had thus placed the moon and two of the moving stars in the *purus aether*, and the sun and the three remaining moving stars in the *lucidus ignis*. Since these spheres were moved by the winds, their contained planets would be subject to the same influences. In the *Liber Divinorum Operum*, however, she has come to realize how independent the movements of the planets really are, and she invokes a special cause for their vagaries. 'I looked and behold in the outer fire (*lucidus ignis*) there appeared a circle which girt about the whole firmament from the east westward. From it a blast produced a movement from west to east in the opposite direction to the movement of the firmament. But this blast did not give forth his breath earthward as did the other winds, but instead thereof it governed the course of the planets.'² The source of the blast is represented in the Lucca MS. as the head of a supernatural being with a human face (Plate VIII).

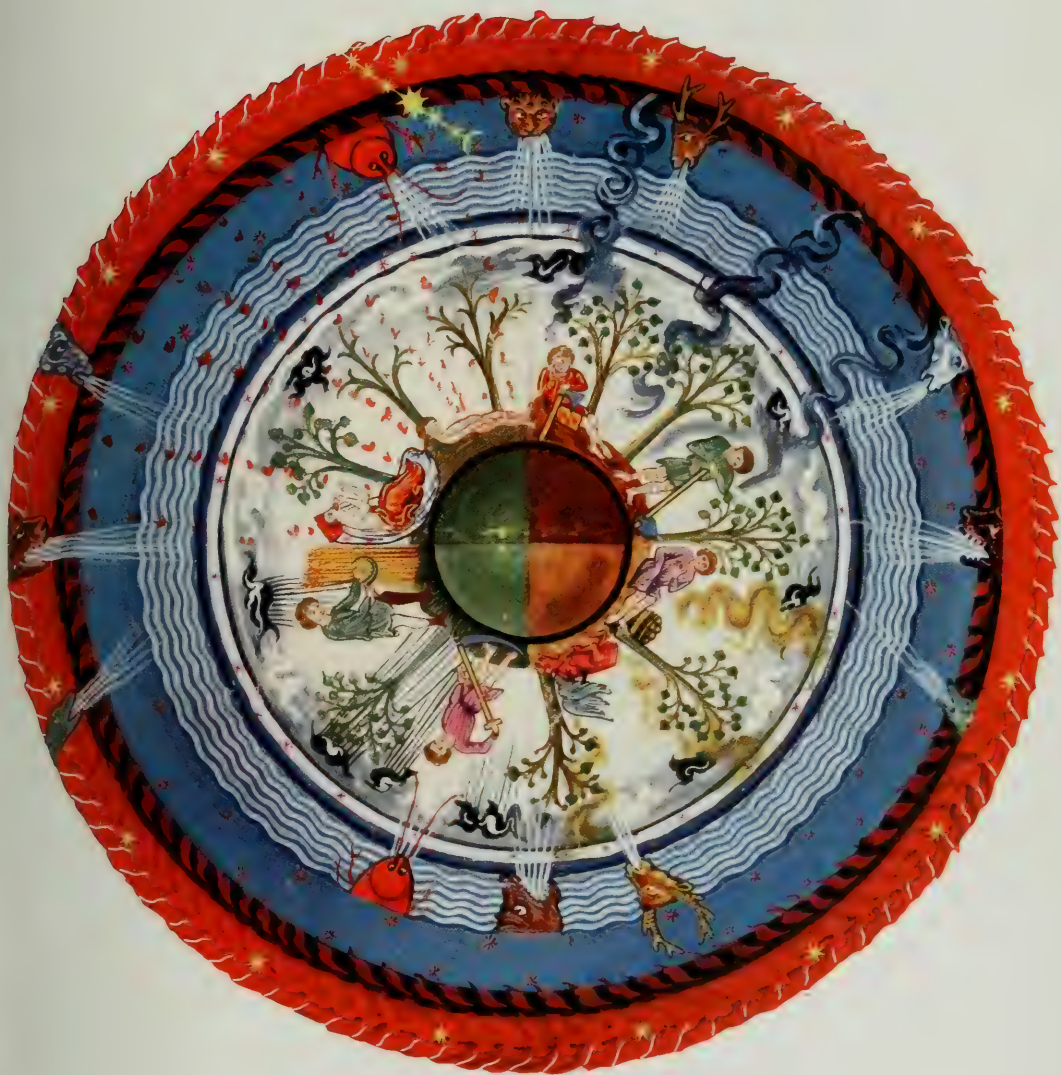
These curious passages were written at some date after 1163, when Hildegard was at least 65 years old. They reveal our pro-

¹ Migne, col. 751.

² Migne, col. 791.



PLATE VIII. THE MACROCOSM THE MICROCOSM
AND THE WINDS



CELESTIAL INFLUENCES ON MEN ANIMALS AND PLANTS

phetess attempting to revise much of her earlier theory of the universe, and while seeking to justify her earlier views, endeavouring also to bring them into line with the new science that was now just beginning to reach her world. Note that (a) the universe has become round; (b) there is an attempt to arrange the zones according to their density, i. e. from without inwards, fire, air (ether), water, earth; (c) exact measurements are given; (d) the watery zone is continued earthward so as to mingle with the

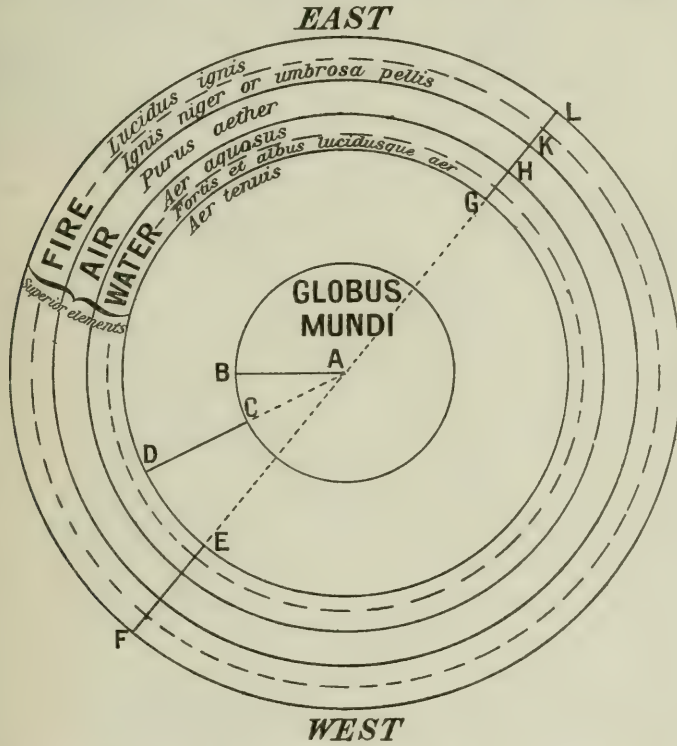


FIG. 3. HILDEGARD'S SECOND SCHEME OF THE UNIVERSE
 Reconstructed from her measurements. AB, CD, and EF are all equal to each other, as are also GH, HK, and KL. The clouds are situated in the outer part of the *aer tenuis*, and form a prolongation downwards from the *aer aquosus* towards the earth.

central circle. In all these and other respects she is joining the general current of mediaeval science then beginning to be moulded by works translated from the Arabic. Her knowledge of the movements of the heavenly bodies is entirely innocent of the doctrine of epicycles, but in other respects her views have come to resemble those, for instance, of Messahalal, one of the simplest and easiest writers on the sphere available in her day. Furthermore, her conceptions have developed so as to fit in with the

macrocosm-microcosm scheme which she grasped about the year 1158. Even in her latest work, however, her theory of the universe exhibits differences from that adopted by the schoolmen, as may be seen by comparing her diagram with, for example, the scheme of Dante (Fig. 4).

Like many mediaeval writers, Hildegard would have liked to imagine an ideal state of the elemental spheres in which the rarest, fire, was uppermost, and the densest, earth, undermost. Such a scheme was, in fact, purveyed by Bernard Sylvestris and by Messahalāh. Her conceptions were however disturbed by the awkward facts that water penetrated below the earth, and indeed sought the lowest level, while air and not water lay immediately above the earth's surface. Mediaeval writers adopted various devices and expended a great amount of ingenuity in dealing with this discrepancy, which was a constant source of obscurity and confusion. Hildegard devotes much space and some highly involved allegory both in the *Scivias* and in the *Liber Divinorum Operum* to the explanation of the difficulty, while Dante himself wrote a treatise in high scholastic style on this very subject.¹

VII. MACROCOSM AND MICROCOSM

The winds and elements of the outer universe, the macrocosm, become in Hildegard's later schemes intimately related to structures and events within the body of man himself, the microcosm, the being around whom the universe centres. The terms *macrocosm* and *microcosm* are not employed by her, but in her last great work, the *Liber Divinorum Operum*, she succeeds in most eloquent and able fashion in synthesizing into one great whole, centred around this doctrine, her theological beliefs and her physiological knowledge, together with her conceptions of the working of the human mind and of the structure of the universe. The work is thus an epitome of the science of the time viewed through the distorting medium of this theory. In studying it the modern reader is necessarily hampered by the bizarre and visionary form into which the whole subject is cast. Nevertheless the scheme, though complex and difficult, is neither incoherent nor insane, as at first sight it may seem. On the contrary, it is a highly

¹ The *Quaestio de Aqua et Terra* is doubtless a genuine, albeit the least pleasing, production of the great poet. The genuineness is established by Vincenzo Balgi in his edition, Modena, 1907.



PLATE X. A CRUCIFIX IN THE UFFIZI GALLERY
About the middle of the XIIIth Century

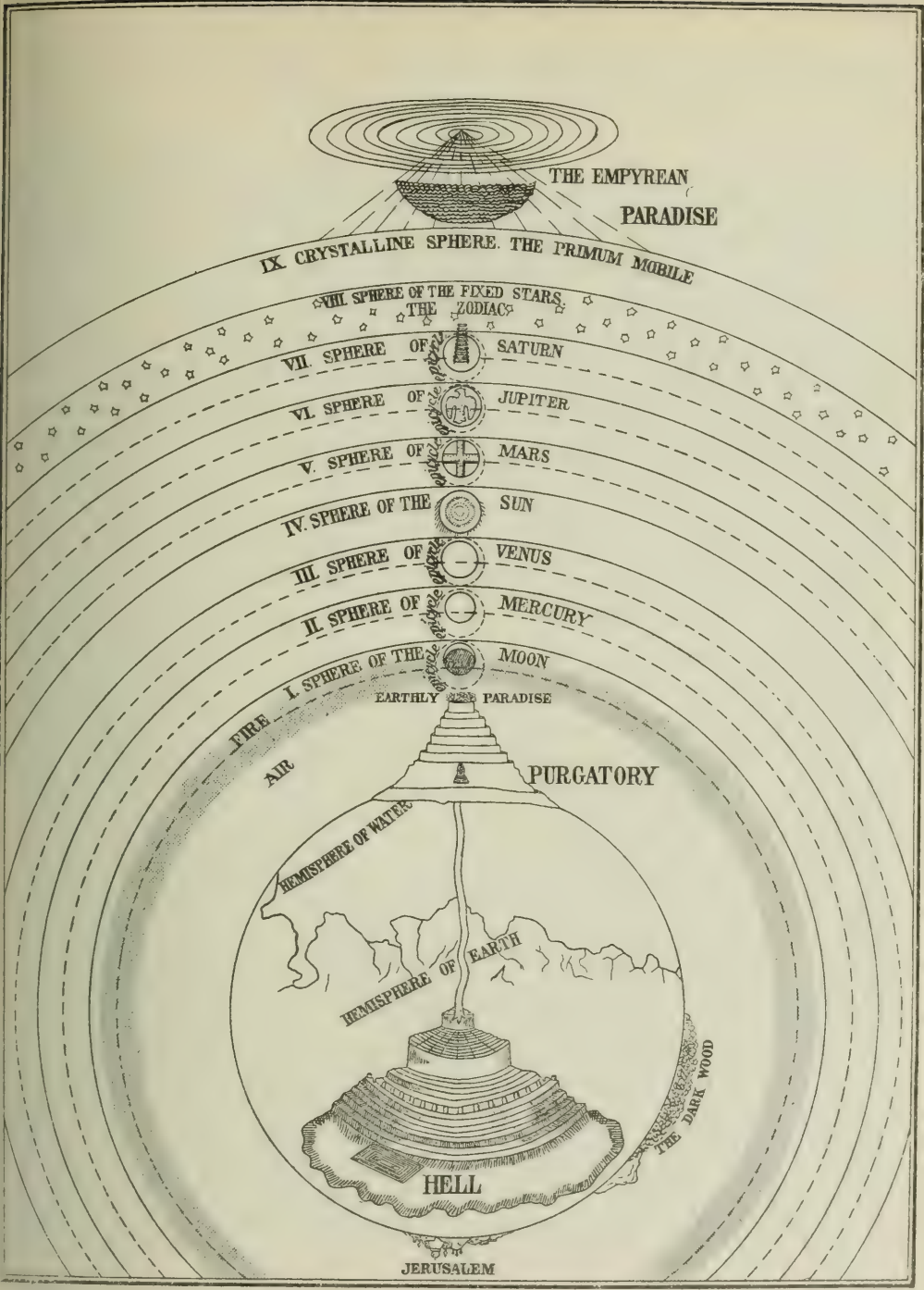


FIG. 4. DANTE'S SCHEME OF THE UNIVERSE

Slightly modified from Michelangelo Caetani, duca di Sermoneta, *La materia della Divina Commedia di Dante Allighieri dichiarata in VI tavole*, Monte Cassino, 1855.

systematic and skilful presentment of a cosmic theory which for centuries dominated scientific thought.

As an explanation of the complexity of existence which thinkers of all ages have sought to bring within the range of some simple formula, this theory of the essential similarity of macrocosm and microcosm held in the Middle Ages, during the Renaissance, and even into quite modern times, a position comparable to that of the theory of evolution in our own age. If at times it passed into folly and fantasy, it should be remembered that it also fulfilled a high purpose. It gave a meaning to the facts of nature and a formula to the naturalist, it unified philosophic systems, it exercised the ingenuity of theologians, and gave a convenient framework to prophecy, while it seemed to illumine history and to provide a key and meaning to life itself. Even now it is not perhaps wholly devoid of message, but as a phenomenon in the history of human thought, a theory which appealed to such diverse scientific writers as Seneca, Albertus Magnus, Paracelsus, Gilbert, Harvey, Boyle, and Leibnitz, is surely worthy of attention.

In essaying to interpret the views of our authoress on this difficult subject, we rely mainly on the text of the *Liber Divinorum Operum*, supplemented by the beautiful illuminations of that work which adorn the Lucca MS. The book opens with a truly remarkable vision (Plate VI):

‘ I saw a fair human form and the countenance thereof was of such beauty and brightness that it had been easier to gaze upon the sun. The head thereof was girt with a golden circlet through which appeared another face as of an aged man. From the neck of the figure on either side sprang a pinion which swept upward above the circlet and joined its fellow on high. And where on the right the wing turned upward, was portrayed an eagle’s head with eyes of flame, wherein appeared as in a mirror the lightning of the angels, while from a man’s head in the other wing the lightning of the stars did radiate. From either shoulder another wing reached to the knees. The figure was robed in brightness as of the sun, while the hands held a lamb shining with light. Beneath, the feet trampled a horrible black monster of revolting shape, upon the right ear of which a writhing serpent fixed itself.’¹

The image declares its identity in words reminiscent of the Wisdom literature or of passages in the hermetic writings, but which seem in fact to be partly borrowed from Bernard Sylvestris.

¹ Migne, col. 741.

From the LUCCA MS. fo. 86 v

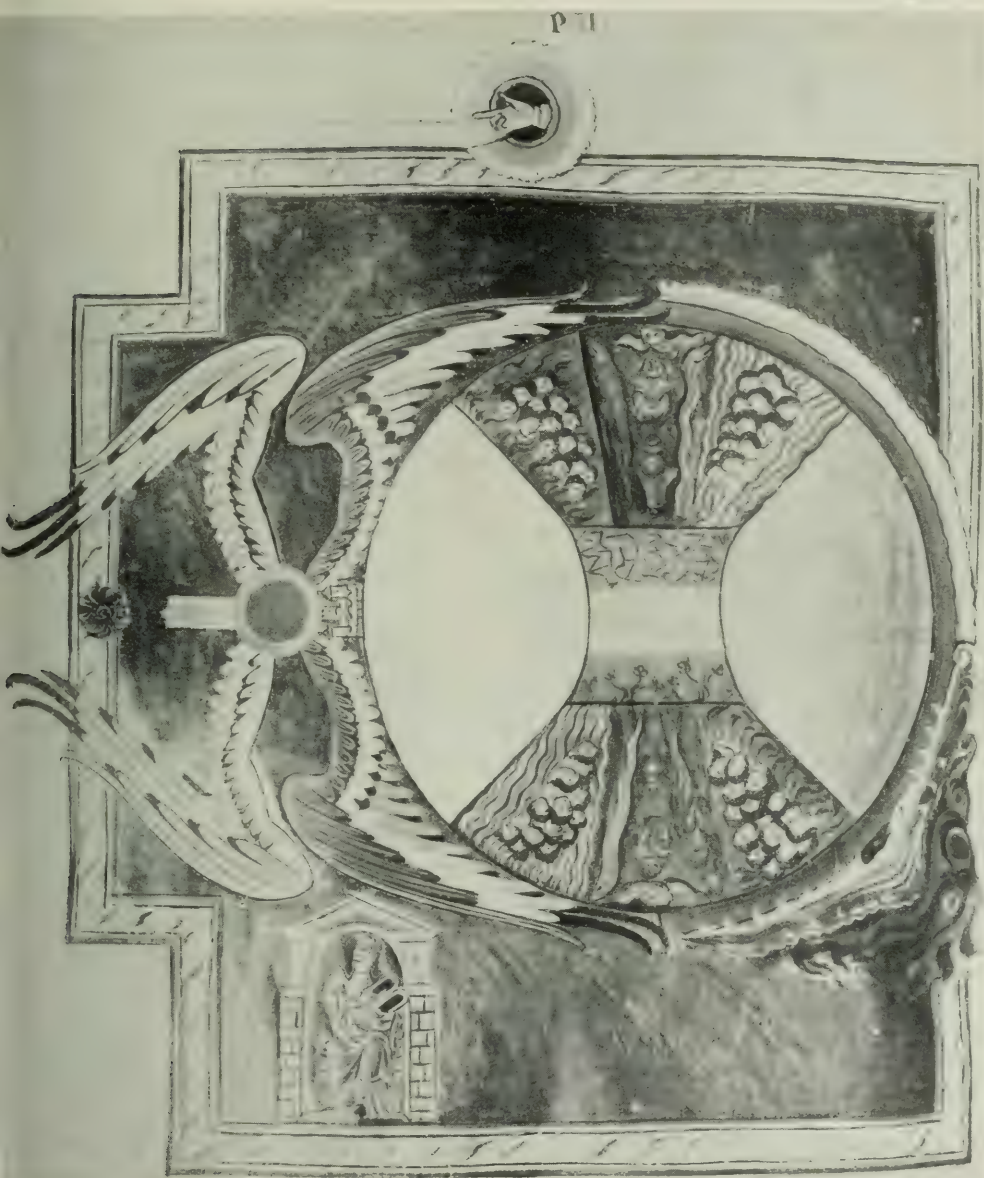


PLATE XI. THE STRUCTURE OF THE MUNDANE SPHERE



PLATE XIIa. MAN'S FALL AND
THE DISTURBANCE OF THE
ELEMENTAL HARMONY



PLATE XIIb. THE NEW
HEAVEN AND THE NEW
EARTH

'I am that supreme and fiery force that sends forth all the sparks of life. Death hath no part in me, yet do I allot it, wherefore I am girt about with wisdom as with wings. I am that living and fiery essence of the divine substance that glows in the beauty of the fields. I shine in the water, I burn in the sun and the moon and the stars. Mine is that mysterious force of the invisible wind. I sustain the breath of all living. I breathe in the verdure and in the flowers, and when the waters flow like living things, it is I. I formed those columns that support the whole earth. . . . I am the force that lies hid in the winds, from me they take their source, and as a man may move because he breathes so doth a fire burn but by my blast. All these live because I am in them and am of their life. I am wisdom. Mine is the blast of the thundered word by which all things were made. I permeate all things that they may not die. I am life.'¹

Hildegard thus supposes that the whole universe is permeated by a single living spirit, the figure of the vision. This spirit of the macrocosm, the *Nous* or 'world spirit' of the hermetic and Neoplatonic literature, the impersonated *Nature*, as we may perhaps render it, is in its turn controlled by the Godhead that pervades the form and is represented rising from its vertex as a second human face. Nature, the spirit of the cosmic order, controls and holds in subjection the hideous monster, the principle of death and dissolution, the *Hyle* or primordial matter of the Neoplatonists, whose chaotic and anarchic force would shatter and destroy this fair world unless fettered by a higher power.

With the details of the visionary figure we need not delay,² but we pass to the description of the structure of the macrocosm itself, to which the second vision is devoted (Plate VII). Here appears the same figure of the macrocosmic spirit. But now the head and feet only are visible, and the arms are outstretched to enclose the disk of the universe which conceals the body. Although the macrocosm now described is considerably altered from Hildegard's original scheme of the universe, she yet declares, 'I saw in the bosom of the form the appearance of a disk of like sort to that which twenty-eight years before I had seen in the third vision, set forth in my book of *Scivias*'.³ The zones of this disk are

¹ Migne, col. 743.

² It is outside our purpose to attempt a full elucidation of Hildegard's allegory. The eagle in the right wing signifies the power of divine grace, while the human head in the left wing indicates the powers of the natural man. To the bosom of the figure is clasped the Lamb of God.

³ Migne, col. 751.

then described (Plates VII, VIII, and XI and Fig. 2). They are from without inwards :

- (a) The *lucidus ignis*, containing the three outer planets, the sixteen principal fixed stars, and the south wind.
- (b) The *ignis niger*, containing the sun, the north wind, and the materials of thunder, lightning, and hail.
- (c) The *purus aether*, containing the west wind, the moon, the two inner planets, and certain fixed stars.
- (d) The *aer aquosus*, containing the east wind.
- (e) The *fortis et albus lucidusque aer*, where certain other fixed stars are placed.
- (f) The *aer tenuis*, or atmosphere, in the outer part of which is the zone of the clouds.

From all these objects, from the spheres of the elements, from the sun, moon, and other planets, from the four winds each with their two collaterals, from the fixed stars, and from the clouds, descend influences, indicated by lines, towards the figure of the macrocosm.

The microcosm is then introduced.

‘ And again I heard the voice from heaven saying, “ God, who created all things, wrought also man in his own image and similitude, and in him he traced [*signavit*] all created things, and he held him in such love that he destined him for the place from which the fallen angel had been cast.” ’¹

The various characters of the winds are expounded in a set of curious passages in which the doctrine of the macrocosm and microcosm is further mystically elaborated. An endeavour is made to attribute to the winds derived from the different quarters of heaven qualities associated with a number of animals.² The conception is illustrated and made comprehensible by the miniatures in the Lucca MS. (Plates VII and VIII).

‘ In the middle of the disk [of the universe] there appeared the form of a man, the crown of whose head and the soles of whose feet extended to the *fortis et albus lucidusque aer*, and his hands were outstretched right and left to the same circle. . . . Towards these parts was an appearance as of four heads ; a leopard, a wolf, a lion, and a bear. Above the head of the figure in the zone of the *purus aether*, I saw the head of the leopard emitting a blast from its mouth, and on the right side of the mouth the blast, curving itself somewhat backwards, was formed into a crab’s

¹ Migne, col. 744.

² *Liber Divinorum Operum*, part i, visions 2 and 3.

head . . . with two chelae; while on the left side of the mouth a blast similarly curved ended in a stag's head. From the mouth of the crab's head, another blast went to the middle of the space between the leopard and the lion; and from the stag's head a similar blast to the middle of the space between the leopard and the bear . . . and all the heads were breathing towards the figure of the man. Under his feet in the *aer aquosus* there appeared as it were the head of a wolf, sending forth to the right a blast extending to the middle of the half space between its head and that of the bear, where it assumed the form of the stag's head; and from the stag's mouth there came, as it were, another breath which ended in the middle line. From the left of the wolf's mouth arose a breath which went to the midst of the half space between the wolf and the lion, where was depicted another crab's head . . . from whose mouth another breath ended in the same middle line. . . . And the breath of all the heads extended sideways from one to another. . . . Moreover on the right hand of the figure in the *lucidus ignis*, from the head of the lion, issued a breath which passed laterally on the right into a serpent's head and on the left into a lamb's head . . . similarly on the figure's left in the *ignis niger* there issued a breath from the bear's head ending on its right in the head of [another] lamb, and on its left in another serpent's head. . . . And above the head of the figure the seven planets were ranged in order, three in the *lucidus ignis*, one projecting into the *ignis niger* and three into the *purus aether*. . . . And in the circumference of the circle of the *lucidus ignis* there appeared the sixteen principal stars, four in each quadrant between the heads. . . . Also the *purus aether* and the *fortis et albus lucidusque aer* seemed to be full of stars which sent forth their rays towards the clouds, whence . . . tongues like rivers descended to the disk and towards the figure, which was thus surrounded and influenced by these signs.'¹

The third vision is devoted to an account of the human body, the microcosm (Plate VIII), with a comparison of its organs to the parts of the macrocosmic scheme, together with a detailed account of the effects of the heavenly bodies on the humours in man, the whole brought into a strongly theological setting. Some of these views are set forth below in the chapter on anatomy and physiology.

The fourth vision explains the influence of the heavenly bodies and of the superior elements on the power of nature as exhibited on the surface of the earth. It is illustrated by a charming miniature in the Lucca MS. (Plate IX).

¹ Migne, cols. 752-5.

‘I saw that the upper fiery firmament was stirred, so that as it were ashes were cast therefrom to earth, and they produced rashes and ulcers in men and animals and fruits.’ These effects are shown in the left upper quadrant of Plate IX, where the ashes are seen proceeding from the *lucidus ignis*, the ‘upper fiery firmament’. Two figures are seen, a female semi-recumbent, who lifts a fruit to her mouth, and a male figure fully recumbent, on whose legs a rash is displayed. The trees also in this quadrant show the effects of the ashes, two of them being denuded of fruit and foliage.

‘Then I saw that from the *ignis niger* certain vapours (*nebulæ*) descended, which withered the verdure and dried up the moisture of the fields. The *purus æther*, however, resisted these ashes and vapours, seeking to hold back these plagues.’ These vapours may be seen in the right upper quadrant of Plate IX. They descend from the *ignis niger*, attenuate for a space in the *purus æther*, and then descend through the other zones on to an arid and parched land. Here are two husbandmen; one sits forlornly clasping his axe, while the other leans disconsolately upon his hoe. On the legs of the latter a rash may be distinguished.

‘And looking again I saw that from the *fortis et albus lucidusque aer* certain other clouds reached the earth and infected men and beasts with sore pestilence, so that they were subjected to many ills even to the death, but the *aer aquosus* opposed that influence so that they were not hurt beyond measure.’ This scene is portrayed in the right lower quadrant of Plate IX. Here is a husbandman in mortal anguish. He has gathered his basket of fruit and now lies stricken with the pestilence. His left hand is laid on his heart, while his right hangs listless on his thigh, pointing to tokens of plague upon his legs. Beyond lies the dead body of a beast on which a carrion bird has settled.

‘Again I saw that the moisture in the *aer tenuis* was as it were boiling above the surface of the earth, awakening the force of the earth and making fruits to grow.’¹ This happier scene is represented in the left lower quadrant of Plate IX. Here the beneficent fertilizing influence is falling on trees and herbs and the happy husbandmen are reaping its results.

The main outline of the *Liber Divinorum Operum* is, we believe, borrowed from the work of Bernard Sylvestris of Tours, *De mundi*

¹ Migne, col. 807.



PLATE XIII. THE LAST JUDGEMENT AND FATE
OF THE ELEMENTS



PLATE XIV. DIAGRAM OF THE RELATION OF HUMAN AND COSMIC PHENOMENA IXth Century

universitate libri duo sive megacosmus et microcosmus.¹ In this composition by a teacher at the cathedral school of Chartres,² the gods and goddesses of the classical pantheon flit across the stage, for all the world as though the writer were a pagan, and the work might be thought to be the last one from which our pious authoress would borrow. The *De mundi universitate* is alternately in prose and verse and betrays an acquaintance with the classics very rare at its date. 'The rhythm of the hexameters is clearly that of Lucan, while the vocabulary is mainly of Ovid.'³ The mythology is founded mainly on the *Timaeus*. The eternal *seminaria* of created things are mentioned, and it has been conjectured that the work exhibits traces of the influence of Lucretius,⁴ but the general line of thought is clearly related to Neoplatonic literature. Thus the *anima universalis* of Neoplatonic writings can be identified with the *Nous* or *Noys* of Bernard. This principle is contrasted with primordial matter or *Hyle*. The parallel character of the *Liber Divinorum Operum* and the *De mundi universitate* can be illustrated by a few extracts from the latter. It will be seen that although the general setting is changed, yet Hildegard's figure of the spirit of the macrocosm is to be identified with Bernard's *Noys*. *Hyle*, on the other hand, becomes in Hildegard's plan the monstrous form, the emblem of brute matter, on which the spirit of the universe tramples.

'In huius operis primo libro qui Megacosmus dicitur, id est maior mundus, Natura ad Noym, id est Dei providentiam, de primae materiae, id est hyles, confusione querimoniam quasi cum lacrimis agit et ut mundus pulchrius petit. Noys igitur eius mota precibus petitioni libenter annuit et ita quatuor elementa ab invicem seiungit. Novem ierarchias angelorum in coelo ponit. stellas in firmamento figit. signa disponit. sub signis orbes septem planetarum currere facit. quatuor ventos cardinales sibi invicem opponit. Sequitur genesis animantium et terrae situs medius. . . .

'In secundo libro qui Microcosmus dicitur, id est minor mundus, Noys ad Naturam loquitur et de mundi expolitione gloriatur et in operis sui completionem se hominem plasmaturam pollicetur. Iubet

¹ The work is printed by C. S. Barach and J. Wrobel, Innsbruck, 1876. The writers, however, confuse Bernard Sylvestris of Tours with his somewhat older contemporary, Bernard of Chartres.

² A. Clerval, *Les Écoles de Chartres au Moyen Âge*, Paris, 1895.

³ J. E. Sandys, *History of Classical Scholarship*, Cambridge, 1903, vol. i, p. 515.

⁴ R. Lane Poole, *Illustrations of the History of Mediaeval Thought in the Departments of Theology and Ecclesiastical Politics*, Oxford, 1884, pp. 118, 219.

igitur Uraniam, quae siderum regina est, et Physin, quae rerum omnium est peritissima, sollicite perquirat. Natura protinus iubenti obsequitur et per caelestes circulos Uraniam quaeritans eam sideribus inhiantem reperit, eiusque itineris causa praecognita se operis et itineris comitem Urania pollicetur. . . . Subitoque ibi Noys affuit suoque velle eis ostenso trinas speculationes tribus assignando tribuit & ad hominis plasmationem eas impellit. Physis igitur de quatuor elementorum reliquiis hominem format et a capite incipiens membratim operando opus suum in pedibus consummat. . . .

‘Noys ego scientia et divinae voluntatis arbitraria ad dispositionem rerum, quem ad modum de consensu eius accipio, sic meae administrationis officia circumduco. . . .

‘(Noys) erat fons luminis, seminarium vitae, bonum bonitatis divinae, plenitudo scientiae quae mens altissimi nominatur. Ea igitur noys summi & exsuperantissimi Dei est intellectus et ex eius divinitate nata natura. . . . Erat igitur videre velut in speculo tersiore quicquid generationi quicquid operi Dei secretior destinaret affectus.’¹

Hildegard’s conception of macrocosm and microcosm, which was thus probably borrowed from Bernard Sylvestris, has analogies also to those well-known figures illustrating the supposed influence of the signs of the zodiac on the different parts of the body.² Such figures, with the zodiacal symbols arranged around a figure of Christ, may be seen in certain MSS. anterior to Hildegard,³ while the influence of the ‘Melothesia’, to give it the name assigned by Porphyry, has been traced through its period of efflorescence at the Renaissance (Plates xv,⁴ xvi,⁵ and

¹ Barach and Wrobel, *loc. cit.*, pp. 5–6, 9 and 13.

² For a general consideration of these figures see K. Sudhoff, *Archiv für Geschichte der Medizin*, i. 157, 219; ii. 84.

³ E. Wickersheimer, ‘Figures médico-astrologiques des neuvième, dixième et onzième siècles’, *Transactions of the Seventeenth International Congress of Medicine, Section XXIII, History of Medicine*, p. 313, London, 1913.

⁴ The MS. from which Plate xv is taken (*Paris, Bibl. nat., Latin 7028*) is entitled *Scholium de duodecim zodiaci signis et de ventis*. It was once the property of St. Hilaire the Great of Poitiers. The legend above our figure reads, ‘Secundum philosophorum deliramenta notantur duodecim signa ita ab ariete incipiamus’. The relation of the signs to the parts of the body is different in this eleventh-century MS. from that which was widely accepted in the astrology of the thirteenth and fourteenth centuries as illustrated in Plate xvi.

⁵ The MS. from which Plate xvi is taken (*Paris, Bibl. nat., Latin 11229*) was written about the end of the fourteenth century. It has been described by K. Sudhoff, *Arch. f. Gesch. d. Med.*, ii. 84, Leipzig, 1910. The relation of the central figure to the signs of the zodiac in this plate bears a manifest resemblance

xvii,¹ compare with Plates vii and viii) right down to our own age and country, where it still appeals to the ignorant and foolish.²

Hildegard often interprets natural events by means of a peculiarly crude form of the doctrine, as when she describes how 'if the excess of waters below are drawn up to the clouds (by the just judgment of God in the requital of sinners), then the moisture from the *aer aquosus* transudes through the *fortis et albus lucidusque aer* as a draught drunk into the urinary bladder; and the same waters descend in an inundation'.³

Again, events in the body of man are most naively explained on the basis of the nature of the external world as she has pictured it.

'The humours at times rage fiercely as a leopard and again they are softened, going backwards as a crab;⁴ or they may show their diversity by leaping and going as a stag, or they may be as a wolf in their ravening, and yet again they may invade the body of man after the manner of both wolf and crab. Or else they may show forth their strength unceasingly as a lion, or as a serpent they may go now softly, now violently, and at times they may be gentle as a lamb and at times again they may growl as an angered bear, and at times they may partake of the nature of the lamb and of the serpent.'⁵

to the relation of the central figure to the beasts' heads in Plate vii. The lines which cross and recross the figure in Plate vii are analogous also to the lines of influence of Plate xvi. The verse above the figure in Plate xvi is taken from the *Flos medicinae scholae Salerni*; cp. de Renzi, loc. cit., i. 486. This Melothesia and that of the next figure is identical with that propounded in Manilius, ii. 453 (edition of H. W. Garrod, Oxford, 1911).

¹ Plate xvii is from an early German block book. It exhibits a scheme closely parallel to Plate vii. The universe in Plate xvii is represented as a series of concentric spheres, *earth* innermost, followed by *water*, *air*, and *fire*. In the outermost zone hover the angels who have replaced the beast's head of Hildegard's scheme. The whole world is embraced by the figure of the Almighty, much as in Plate vii.

² See E. Wickersheimer, 'La médecine astrologique dans les almanachs populaires du xx^e siècle', *Bulletin de la Société française d'histoire de la médecine*, x (1911), pp. 26-39.

³ Migne, col. 757. This phrase is reproduced in a mediaeval Irish version of the work of Messahalāh. See Maura Power, *An Irish Astronomical Text*, Irish Text Society, London, 1912.

⁴ The word *cancer* is here used, but the crab goes sideways, not backwards. By *cancer* Hildegard, who had never seen the sea, probably means the crayfish, an animal fairly common in the Rhine basin. It is the head of a crayfish or lobster that is figured in the miniatures of the vision of the macrocosm in the Lucca MS., and a similar organism frequently serves for the sign Cancer in the mediaeval zodiacal medical figures, as in Plate xv of this essay.

⁵ Migne, cols. 3, 791-2.

Having completed her general survey of the macrocosm (Vision II), and having investigated in detail the structure of man's body, the microcosm, in terms of the greater universe (Vision III), and discussed the influence of the heavenly bodies on terrestrial events (Vision IV), Hildegard turns to the internal structure of the terrestrial sphere (Vision V). This vision is illustrated by the figure in the Lucca MS. reproduced in Plate XI.

Upon the surface of the earth towards the east stands the building which symbolizes the *aedificium* of the church, a

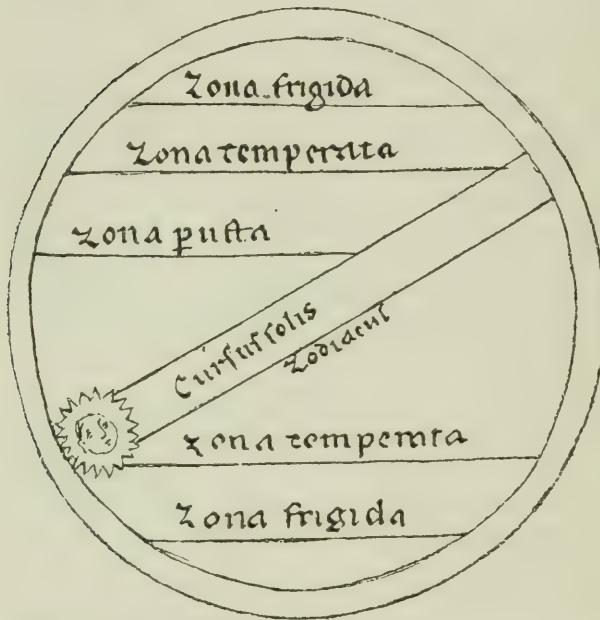


FIG. 5. From Herrade de Landsberg's *Hortus deliciarum*, after Straub and Keller.

favourite conception of our authoress. This church is surmounted by a halo, whence proceed a pair of pinions which extend their shelter over a full half of the earth's circumference. As for the rest of the earth's surface, part is within the wide-opened jaws of a monster, the Destroyer, and the remainder is beneath the surface of the ocean. Within the earth are five parts analogous, as she would have us be-

lieve, to the five senses. An eastern clear arc and a western clouded one signify respectively the excellence of the orient where Zion is situated, and the Cimmerician darkness of the occidental regions over which the shadow of the dragon is cast. Centrally is a quadrangle area divided into three zones where the qualities of heat and cold and of a third intermediate 'temperateness' (*temperies*) are stored. North and south of this are two areas where purgatory is situated. Each is shaped like a truncated cone and composed also of three sectors. Souls are seen suffering in one sector the torment of flame, in another the torment of water, while in the third or intermediate sector lurk monsters



PLATE XV. AN XITH CENTURY FRENCH MELOTHESIA

Coz spirit pulmo laqueur. fel comouet tres
Splen videre facit corit amare seuur.



Post hunc sequitur ultima luna subest -

PLATE XVI. A MELOTHESIA OF ABOUT 1400



PLATE XVII. A GERMAN BLOCK BOOK
First Half of XVth Century. Heidelberg University Library



PLATE XVIII. AN ANATOMICAL DIAGRAM OF ABOUT 1298
From the Five-Figure Series. Cp. Plate XXXIII

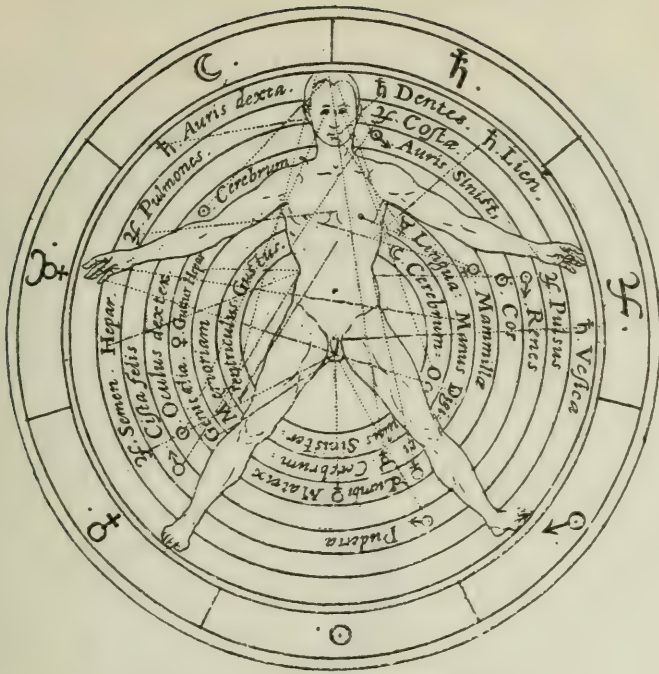


FIG. 6.

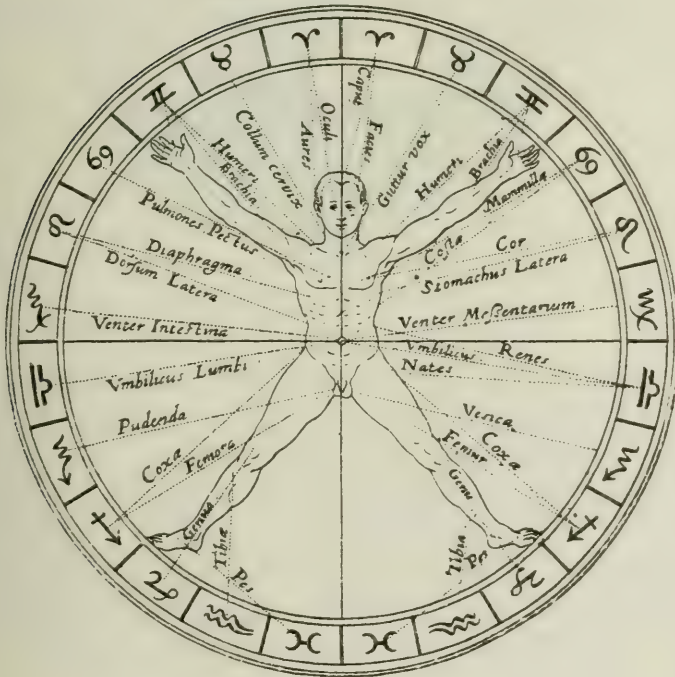


FIG. 7.

MELOTHESIAE

From R. Fludd, *Historia utriusque cosmi*, Oppenheim, 1619, pp. 112 and 113.

and creeping things which add to the miseries of purgatory or at times come forth to earth's surface to plague mankind. These northern and southern sections exhibit dimly by their identically reversed arrangement the belief in the antipodean inversion of climate, an idea hinted several times in Hildegard's writings, but more definitely illustrated by a figure of Herrade de Landsberg (Fig. 5).

Macrocosmic schemes of the type illustrated by the text of Hildegard and by the figures of the Lucca MS. had a great vogue

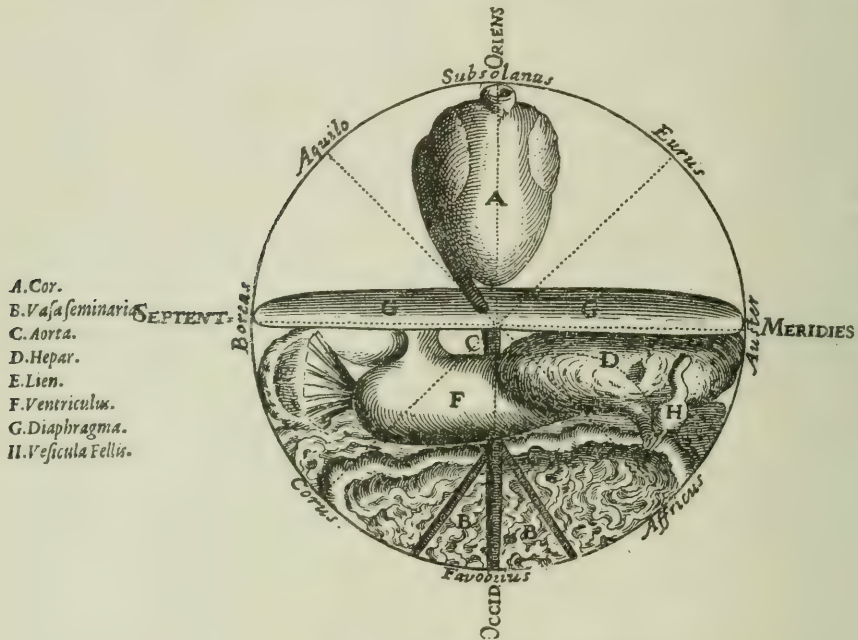


FIG. 8. THE MICROCOSM

From R. Fludd, *Philosophia sacra seu astrologia cosmica*, Frankfurt, 1628, p. 52.

in mediaeval times, and were passed on to later ages. Some passages in Hildegard's work read curiously like Paracelsus (1491-1541),¹ and it is not hard to find a link between these two difficult and mystical writers. Trithemius, the teacher of Paracelsus, was abbot of Sponheim, an important settlement almost within sight of Hildegard's convents on the Rupertsberg and Disibodenberg. Trithemius studied Hildegard's writings with great care and attached

¹ An illustration of this parallelism between Paracelsus and Hildegard is afforded by certain passages in the *Labyrinthus medicorum errantium* and the *Scivias*, lib. i, vis. 4. Especially compare p. 279 et seq. of Huser's edition of the *Opera*, Strasbourg, 1603, with Migne, col. 428.

much importance to them, so that they may well have influenced his pupil. The influence of mediaeval theories of the relation of macrocosm and microcosm is encountered among numerous Renaissance writers besides Paracelsus, and is presented to us, for instance, by such a cautious, balanced, and scientifically-minded humanist as Fracastor. But as the years went on, the difficulty in applying the details of the theory became ever greater and greater. Facts were strained and mutilated more and more to make them fit the Procrustean bed of an outworn theory, which at length became untenable when the heliocentric system of Copernicus and Galileo replaced the geocentric and anthropocentric systems of an earlier age. The idea of a close parallelism between the structure of man and of the wider universe was gradually abandoned by the scientific, while among the unscientific it degenerated and became little better than an insane obsession. As such it appears in the ingenious ravings of the English follower of Paracelsus, the Rosicrucian, Robert Fludd, who reproduced, often with fidelity, the systems which had some novelty five centuries before his time (Figs. 6, 7, and 8). As a similar fantastic obsession this once fruitful hypothesis still occasionally appears even in modern works of learning and industry.¹

VIII. ANATOMY AND PHYSIOLOGY

Hildegard's ideas on these subjects are set out in the fourth vision of the *Liber Divinorum Operum*, which is devoted to a description of man's body according to the macrocosmic scheme. This setting makes her account by no means easy to read, while it increases the difficulty of tracing the origin of her views.

The list of works containing anatomical descriptions available to a German writer in the early Middle Ages is not long. Avicenna was hardly yet accessible, and only such scraps of Galen as appear in Constantine and the Salernitans. The available works may be enumerated thus :

- (a) The short *Anatomia porci* of Copho of Salerno, dating from about 1085.²

¹ A good example is furnished by a work of Isaac Myer, *Qabbalah. The philosophical writings of Solomon ben Yehudah ibn Gebirol or Avicebron and their connection with the Hebrew Qabbalah and Sepher ha-Zohar*, Philadelphia, 1888.

² The most accessible edition is in S. de Renzi's *Collectio Salernitana*, vol. ii, p. 388.

- (b) An anonymous Salernitan anatomy,¹ written about 1100 and largely based on Copho and Constantine.
- (c) The *Liber de humana natura* of Constantine the African, written probably between 1070 and 1085 at Monte Cassino.²
- (d) Constantine's *De communibus medico cognitu necessariis locis*, written about the same time as the above.³ This work is in four books, of which the second, third, and fourth are devoted to anatomy and physiology.
- (e) Here may be placed also Constantine's translation of the *Viaticum* of Isaac Judeus. Both these latter works of Constantine are long and technical, and designed for the use of the trained physician.

In addition to these there was in the Middle Ages a definite anatomic tradition, which expressed itself constantly in:

- (f) A series of five anatomical diagrams representing respectively the arteries, veins, bones, nerves, and muscles⁴ (see Plate XXXIII, opposite page 92 of the present volume). These diagrams were copied in the most servile fashion for centuries, and something very like them has remained in use to this day in Tibet.⁵ The versions, whether in Persia or England, in Germany or Italy, were remarkably uniform.
- (g) In several MSS. there has been found attached to these remarkable diagrams a short text describing the five systems, arteries, veins, nerves, bones, and muscles. This text, however, purporting to be from Galen, has little

¹ Printed in de Renzi, vol. ii, p. 391.

² Printed in *Methodus medendi certa clara et brevis*, Basel, Henricus Petrus, 1541, p. 313.

³ Printed in *Summi in omni philosophia viri constantini africani medici operum reliqua*, Basel, Henricus Petrus, 1539, p. 24.

⁴ Karl Sudhoff, *Tradition und Naturbeobachtung*, Leipzig, 1907; *Ein Beitrag zur Geschichte der Anatomie im Mittelalter*, Leipzig, 1908; 'Drei weitere anatomische Fünfbilderserien aus Abendland und Morgenland' (with Ernst Seidel) and 'Abermals eine neue Handschrift der anatomischen Fünfbilderserie' in *Archiv für Geschichte der Medizin*, Leipzig, 1910 and 1914.

⁵ E. H. C. Walsh, 'The Tibetan Anatomical System', in the *Journal of the Royal Asiatic Society*, London, October 1910, p. 1215; Berthold Laufer, *Beiträge zur Kenntnis der Tibetischen Medizin*, Berlin, 1900; and K. Sudhoff, 'Weitere Beiträge zur Geschichte der Anatomie im Mittelalter', in the *Archiv für Geschichte der Medizin*, vol. viii, p. 143, Leipzig, 1914.



PLATE XIX. BIRTH. THE ARRIVAL AND TRIALS OF THE SOUL

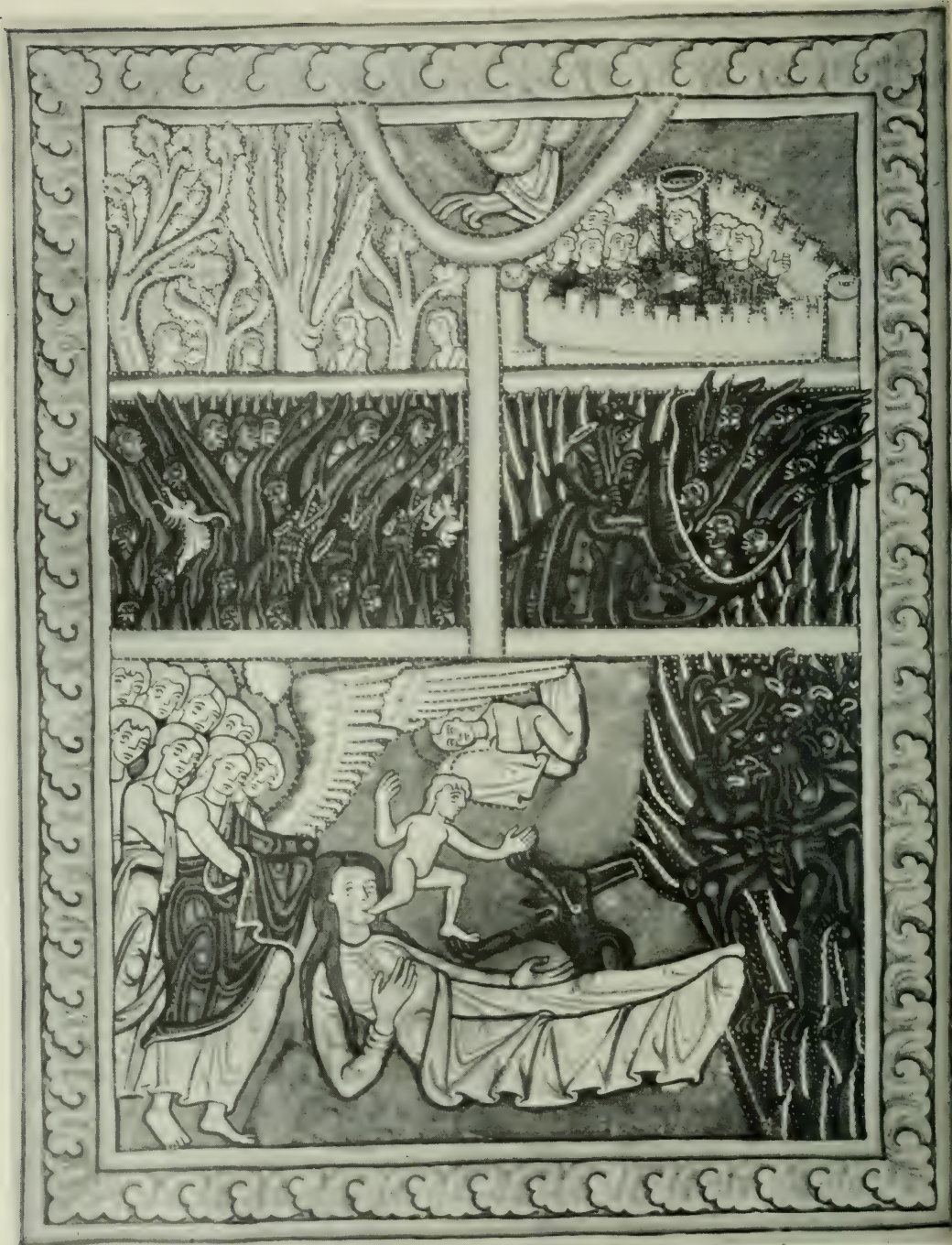


PLATE XX. DEATH. THE DEPARTURE AND FATE
OF THE SOUL

relation to the figures, which it does not really explain, and it should therefore be regarded as a separate work.¹

Of these seven sources it appears to us that (c) and (f)—the short *De humana natura* of Constantine, and the five-figure series—are those on which Hildegard drew. The absence of Arabisms and the scarcity of technical anatomical terms in her writings, her failure to distinguish between veins and arteries, the absence of anything of the nature of myology or osteology, together with the neglect of the spinal marrow as an important organ, make it very unlikely that she consulted Constantine's longer works or the Salernitan authorities or the text of the five-figure series. Her anatomical descriptions resemble those of Constantine's shorter work, on the other hand, in the description of the three vesicles of the brain and their relations to the faculties of the mind, in the treatment of the five senses, in the view of the influence of the planets on the child and the emphasis laid on epilepsy, as well as in the absence of any distinction between arteries and veins, and in the loose doctrines of the humours and of the causes of deformities and monstrosities. In some of these respects also her account of the human body presents points of resemblance to the *De hominis membris ac partibus* of Hugh of St. Victor,² with whom, however, her contact appears to be less close than with Constantine.

We may infer that Hildegard had consulted anatomical diagrams and was accustomed to this method of representing the organs from a passage descriptive of the microcosm, in which she says that 'in the mouth of the figure in whose body was the disk, I saw a light brighter than the light of day, in the form of threads, some circular, some in other geometrical forms, and some shaped like human members belonging to the figure, which was clearly portrayed on the disk upright and accurately limned'.³ These 'circles and geometrical figures' fairly describe the highly diagrammatic manner in which the five-figure series represents the internal organs, and several points suggest that she does indeed refer to this series. Her description of the abdominal muscles

¹ This text, critically treated, has been printed by K. Sudhoff, who, however, regards it as related to the figures: *Archiv für Geschichte der Medizin*, vol. iii, p. 361, Leipzig, 1910.

² Hugh of St. Victor, *De bestiis et aliis rebus*, iii. 60.

³ Migne, col. 755.

(*umbilicus*) 'covering the viscera like a cap', her general descriptions of the vessels (*venae*) and the muscles, and especially her account of the vessels of the leg and of the intimate relations of the main *venae* to the organ of hearing, fits in perfectly with the form of these remarkable diagrams (Plate XVIII).

We here render some of the most important of her general anatomical descriptions :

'The humours may pass to the liver, where wisdom is tested, having been already tempered in the brain by the strength of the spirit, and having absorbed its moisture so that now it is plump, strong, and healthy.

'In the right of man is the liver and its great heat, so that the right is swift to act and to work;¹ but towards the left are heart and lung, which fortify the body for its task and receive their heat from the liver as from a furnace. But the vessels of the liver, affected by the agitation of the humours, trouble the venules of the ear of man and sometimes confound the organ of hearing. . . .

'I saw also that sometimes the humours seek the navel, which covers the viscera as a cap, and holds them in, lest they be dissipated, and maintains their course and preserves the heat both of them and of the veins. . . . But sometimes the humours seek the loins (*lumbos*),² which mock, deceive, and endanger the virile powers and which are held in place by nerves and other vessels; in which, nevertheless, reason flourishes so that man may know what to do and what to avoid. . . .

'And the same humours go to the vessels of the reins and of other members, and pass in their turn to the vessels of the spleen, and then to the lungs and to the heart; and they meet the viscera on the left where they are warmed by the lungs, but the liver warms the right-hand side of the body. And the vessels of the brain, heart, lung, liver, and other parts carry strength to the reins, whose vessels descend to the legs, strengthening them; and returning along with the leg vessels, they unite with the virile organ or with the womb as the case may be.

'And as the stomach absorbs food, or as iron is sharpened on a stone, so do they bring the reproductive power to those parts.

¹ An idea that occurs in Aristotle, *Parts of Animals*, ii, c. 2, but is rejected by Galen.

² Early mediaeval writers held that the *lumbus*, which we have rendered *loin*, was intimately connected with the sexual faculties. Thus Hugh of St. Victor (1095-1141), *De bestiis et aliis rebus*, iii. 60 'Lumbi a libidinis lascivia dicti, quia in viris causa corporeae voluptatis in ipsis est, sicut in umbilico feminis. Unde et ab Iob in exordio sermonis dictum est, *accinge sicut vir lumbos tuos*, ut in his esset resistendi praeeparatio, in quibus est libidinis usitata dominandi occasio.'



Prima uisio tertiae partis.



T EGO
homo
sumpta
ab aliis
hominibus
que
nō sū digna
nomi

nari homo ppter t̄migr̄sionē legis
dī. cū deberem eē iusta & sim iniusta.
nō qd̄ dī creatura sum ipsi gr̄a. que
me etiā saluabit. uidi ad orientem.
& ecce illic conspexi uelut lapidem
unū totū integrū inmisē latitudi
nis atq; altitudinis. habentē ferreū
colore. & sup̄ ipsum candidā nubē.
ac sup̄ eā positū regalem tronum ro
tundū. in quo sedebat quidā uiuē
lucidus mirabilis ḡfē. tantq; clara
tis ut nullaten̄ eū p̄spicue possem
reueri. habens q̄si in pectore suo li
mū nigrū & luculentū. tantē lati
tudinis ut alicui magni hominis
pectus eē. circūdatū lapidib; p̄ciosis
atq; margaritis. Et de ip̄so lucido
sedente trono p̄tendebat magnus
circulus auri coloris ut aurora. cui
amplitudinē nullom̄ cōphendere
potui. quans ab oriente ad septentri
onē & ad occidentē atq; ad meridiem.

‘Again, the muscles of the arms, legs, and thighs contain vessels full of humours; and just as the belly has within it viscera containing nourishment, so the muscles of arms, legs, and thighs have both vessels and the [contained] humours which preserve man’s strength. . . . But when a man runs or walks quickly, the nerves about the knees and the venules in the knees become distended. And since they are united with the vessels of the legs, which are numerous and intercommunicate in a net-like manner, they conduct the fatigue to the vessels of the liver, and thus they reach the vessels of the brain, and so send the fatigue throughout the body. But the vessels from the reins pass rather to the left leg than to the right, because the right leg gets its strength more from the heat of the liver. And the vessels of the right leg ascend as far as the renal and kindred vessels, and these latter vessels unite with those of the kidney. And the liver warms the reins which lie in the fatness derived from the humours. . . .

‘The humours in man are distributed in just measure. But when they affect the veins of the liver, his humidity is decreased and also the humidity of the chest is attenuated; so that thus dried, he falls into disease of such a nature that the phlegm is dry and toxic and ascends to the brain. There it produces headache and pain in the eyes and wasting of the marrow, and thus if the moon is in default he may develop the falling evil [epilepsy].

‘The humidity also which is in the umbilicus is dispersed by the same humours, and turned into dryness and hardness, so that the flesh becomes ulcerated and scabby as though he were leprous, if indeed he do not actually become so. And the vessels of his testicles, being adversely affected by these humours, similarly disturb the other vessels, so that the proper humidity is dried up within them; and thus, the humours being withdrawn, impetigos may arise . . . and the marrow of the bones and the vessels of the flesh are dried up, and so the man becomes chronically ill, dragging out his days in languor.

‘But sometimes the humours affect breast and liver . . . so that various foolish thoughts arise . . . and they ascend to the brain and infect it and again descend to the stomach and generate fevers there, so that the man is long sick. Yet again they vex the minor vessels of the ear with superfluity of phlegm; or with the same phlegm they infect the vessels of the lung, so that he coughs and can scarce breathe; and the phlegm may pass thence into the vessels of the heart and give him pain there, or the pain may pass into the side, exciting pleurisy; under such circumstances also, the moon being in defect, the man may lapse into the falling sickness.’¹

¹ Migne, cols. 792-3.

Sometimes Hildegard's anatomical ideas can be paralleled among her contemporaries. Thus the following passage on the relationship of the planets to the brain is well illustrated by a diagram of Herrade de Landsberg.

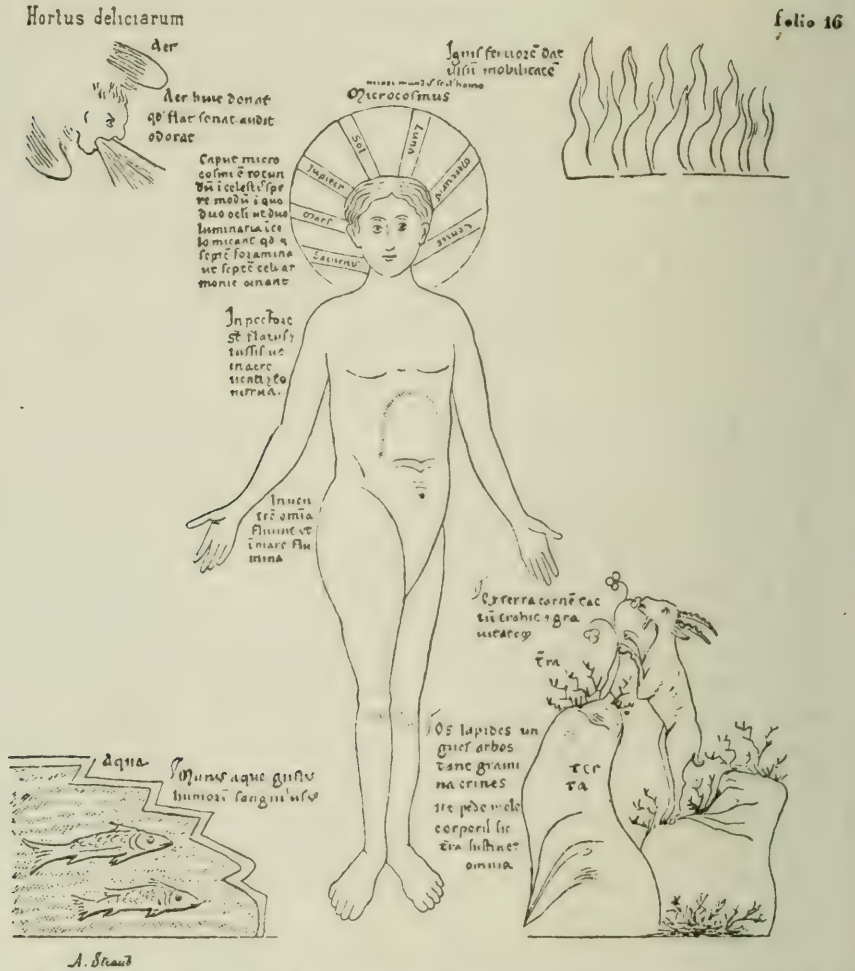


FIG. 9. From Herrade de Landsberg's *Hortus deliciarum*, after Straub and Keller's reproduction.¹

¹ The legend reads as follows: 'Minor mundus scilicet homo. *Microcosmus*. [Then on the head the names of the seven planets.] Caput microcosmi est rotundum in celestis spere modum in quo duo oculi ut duo luminaria in celo micant quod & septem foramina ut septem celi armonie ornant. In pectore sunt flatus & tussis ut in aere uenti & tonitrua. In uentrem omnia fluunt ut in mare flumina. Os lapides unguis arborum dant gramina crines Ut pede mole[m] corporis sic terra sustinet omnia. [At the four corners the following legends:] Aer huic donat quod flat sonat audit odorat. Ignis feruore[m] dat uisum mobilitatem. Aqua. Munus aque gustus humorum sanguinis usus. Ex terra carnem tactum trahit & gravitatem.'

From WIESBADEN CODEX B fo. 41 v



PLATE XXII. THE DAYS OF CREATION AND THE FALL OF MAN

'From the summit of the vessel of the brain to the extremity of the forehead seven equal spaces can be distinguished. Here the seven planets are designated, the uppermost planet in the highest part, the moon in front, the sun in the middle and the other planets distributed among the other spaces' (Fig. 9).

IX. BIRTH AND DEATH AND THE NATURE OF THE SOUL

The method by which the soul enters the body is set forth in a very striking vision in the *Scivias* and is illustrated in the Wiesbaden Codex B by a no less remarkable miniature (Plate XIX). The soul, which contains the element of wisdom, passes into the infant's body while yet within the mother's womb. The *Wisdom of God* is represented as a four-square object, with its angles set to the four quarters of the earth, this form being the symbol of stability. From it a long tube-like process descends into the mother's womb. Down this there passes into the child a bright object, described variously as 'spherical' and as 'shapeless', which 'illumines the whole body' and becomes or develops into the soul.

The birth scene is strikingly portrayed. In the foreground lies the mother with the head and shoulders supported and the right arm raised. In her womb is the infant in the position known to obstetricians as a 'transverse presentation'. Around the child may be distinguished clear traces of the uterine membranes. Near the couch are ranged a group of ten figures who carry vessels containing the various qualities of the child. Above and to the left the Evil One may be seen pouring some noxious substance into one of these vessels, or perhaps abstracting some element of good. The whole scene suggests the familiar fairy tale in which, while all bring pleasant gifts to the child's birth, there comes at last the old witch or the ill-used relative who adds a quota of spitefulness.

The scene is described and expounded as follows :

'Behold, I saw upon earth men carrying milk in earthen vessels and making cheeses therefrom. Some was of the thick kind from which firm cheese is made, some of the thinner sort from which more porous [*tenuis*] cheese is made, and some was mixed with corruption [*tabes*] and of the sort from which bitter cheese is made. And I saw the likeness of a woman having a complete human form within her womb. And then, by a secret disposition of the Most High Craftsman, a fiery sphere having none of the lineaments of a human body possessed the heart of the form, and reached the brain and transfused itself through all the members. . . .

And I saw that many circling eddies possessed the sphere and brought it earthward, but with ever renewed force it returned upward and with wailing asked, "I, wanderer that I am, where am I?" "In death's shadow." "And where go I?" "In the way of sinners." "And what is my hope?" "That of all wanderers."¹ The vision is explained as follows: 'Those whom thou seest carrying milk in earthen vessels are in the world, men and women alike, having in their bodies the seed of mankind from which are procreated the various kinds of human beings. Part is thickened because the seed in its strength is well and truly concocted, and this produces forceful men to whom are allotted gifts both spiritual and carnal. . . . And some had cheeses less firmly curdled, for they in their feebleness have seed imperfectly tempered, and they raise offspring mostly stupid, feeble, and useless. . . . And some was mixed with corruption . . . for the seed in that brew cannot be rightly raised, it is invalid and makes misshapen men who are bitter, distressed, and oppressed of heart, so that they may not lift their gaze to higher things.² . . . And often in forgetfulness of God and by the mocking devil, a *mistio* is made of the man and of the woman and the thing born therefrom is deformed, for parents who have sinned against me return to me crucified in their children.'³ (Compare Constantine *De humana natura*, sections 'De perfectione' and 'De impeditioe'.)

Hildegard thus supposes that the qualities and form of a child are inherited from its parents, but that two factors, the formless soul from the Almighty and the corrupt fluid instilled by the devil, also contribute to the character of offspring. This is the usual mediaeval view and is broadly portrayed in the figure.

The strange conception of the body being formed from the seed, as cheese is precipitated and curdled from milk, is doubtless derived from a passage in the Book of Job:

'Hast thou not poured me out as milk,
And curdled me like cheese?
Thou hast clothed me with skin and flesh,
And knit me together with bones and sinews' (Job x. 10, 11).⁴

When the body has thus taken shape there enters into it the soul which, though at first shapeless, gradually assumes the form of its host, the earthly tabernacle; and at death the soul departs

¹ Migne, col. 415.

² Migne, col. 421.

³ Migne, col. 424.

⁴ The Aristotelian writings also compare the transformation of the material humours into the child's body with the solidification of milk in the formation of cheese.



Plate XXIII. THE VISION OF THE TRINITY

through the mouth with the last breath, as a fully developed naked human shape, to be received by devils or angels as the case may be (Plate xx).

During its residence in the body the soul plays the part usually assigned to it in the earlier mediaeval psychology, before the ideas of Nemesius and Ibn Ghazali had been elaborated and systematized by Albert and Aquinas. Hildegard regards the brain as having three chambers or divisions, corresponding to the three parts of man's nature, an idea encountered in the writings of St. Augustine. Parallel to these there are, she tells us,

'three elements in man by which he shows life; to wit, soul (*anima*), body (*corpus*), and sense (*sensus*). The soul vivifies the body and inspires the senses; the body attracts the soul and reveals the senses; the senses affect the soul and allure the body. For the soul rules the body as a flame throws light into darkness, and it has two principal powers or limbs, the intellect (*intellectus*) and the will (*voluntas*); not indeed that the soul has limbs to move itself, but that it manifests itself thereby as the sun declares himself by his brightness. . . . For the intellect is attached to the soul as the arms to the body: for as the body is prolonged into arms with fingers and hands attached, so the intellect is produced from the soul by the operation of its various powers.'¹

We need follow Hildegard no further into her maze of microcosmology, in which an essential similarity and relationship is discovered between the qualities of the soul, the constitution of the external cosmos, and the structure of the body, a thought which appears as the culmination of her entire system and provides the clue to the otherwise incomprehensible whole.²

X. THE VISIONS AND THEIR PATHOLOGICAL BASIS

For the physical accompaniments and phenomena of Hildegard's visions we have three separate lines of evidence: her own account; the statements of her contemporary biographers, Theodoric and Godefrid; and the miniatures of the Wiesbaden Codex B, probably prepared under her supervision.

It is clear that despite the length and activity of her life, Hildegard did not enjoy normal health. From a very early age she was the subject of trances and visions, and from time to time she was prostrated with protracted illness.

¹ Migne, col. 425.

² Especially in the *Liber Divinorum Operum*, pars I, vis. iv.

‘ God punished me for a time by laying me on a bed of sickness so that the blood was dried in my veins, the moisture in my flesh and the marrow in my bones, as though the spirit were about to depart from my body. In this affliction I lay thirty days while my body burned as with fever, and it was thought that this sickness was laid upon me for a punishment. And my spirit also was ailing, and yet was pinned to my flesh, so that while I did not die, yet did I not altogether live. And throughout those days I watched a procession of angels innumerable who fought with Michael and against the dragon and won the victory. . . . And one of them called out to me, “Eagle! Eagle!¹ why sleepest thou? . . . All the eagles are watching thee. . . . Arise! for it is dawn, and eat and drink.” And then the whole troop cried out with a mighty voice, . . . “Is not the time for passing come? Arise, maiden, arise!” Instantly my body and my senses came back into the world; and seeing this, my daughters who were weeping around me lifted me from the ground and placed me on my bed, and thus I began to get back my strength.

‘ But the affliction laid upon me did not fully cease; yet was my spirit daily strengthened. . . . I was yet weak of flesh, timid of mind, and fearful of pain . . . but in my soul I said, “Lord! Lord! all that Thou puttest upon me I know to be good . . . for have I not earned these things from my youth up?” Yet was I assured He would not permit my soul to be thus tortured in the future life. . . .² Thus was my body seethed as in a pot . . . yet gave I thanks to God, for if this affliction had not been from Him I had surely not lived so long. But although I was thus tortured, yet did I, in supernal vision, often repeat, cry aloud, and write those things which the Holy Spirit willed to put before me.

‘ Three years were thus passed during which the Cherubim pursued me with a flaming sword . . . and at length my spirit revived within me and my body was restored again as to its veins and marrows, and thus I was healed.’³

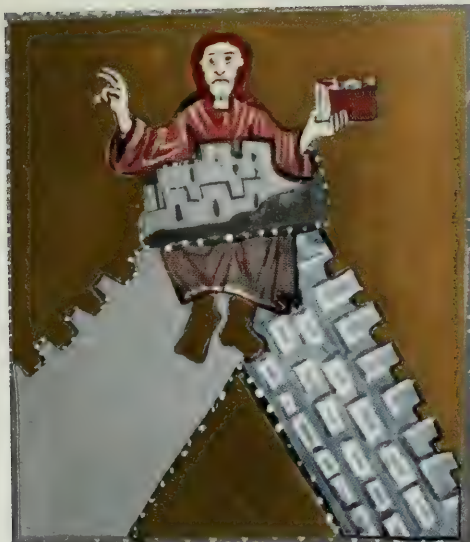
This illness of Hildegard was the longest and the most typical, but by no means the only one through which she passed. She describes her affliction as continuing for long periods, but there can be little doubt, from her history, that during much of the time she was able to carry on some at least of her functions as head of a religious house.

The condition from which she was suffering was clearly a functional nervous disorder; this is sufficiently demonstrated by her

¹ The eagle is frequently in mediaeval writings a symbol of the power of divine grace.

² Migne, col. 110.

³ Migne, col. 111.

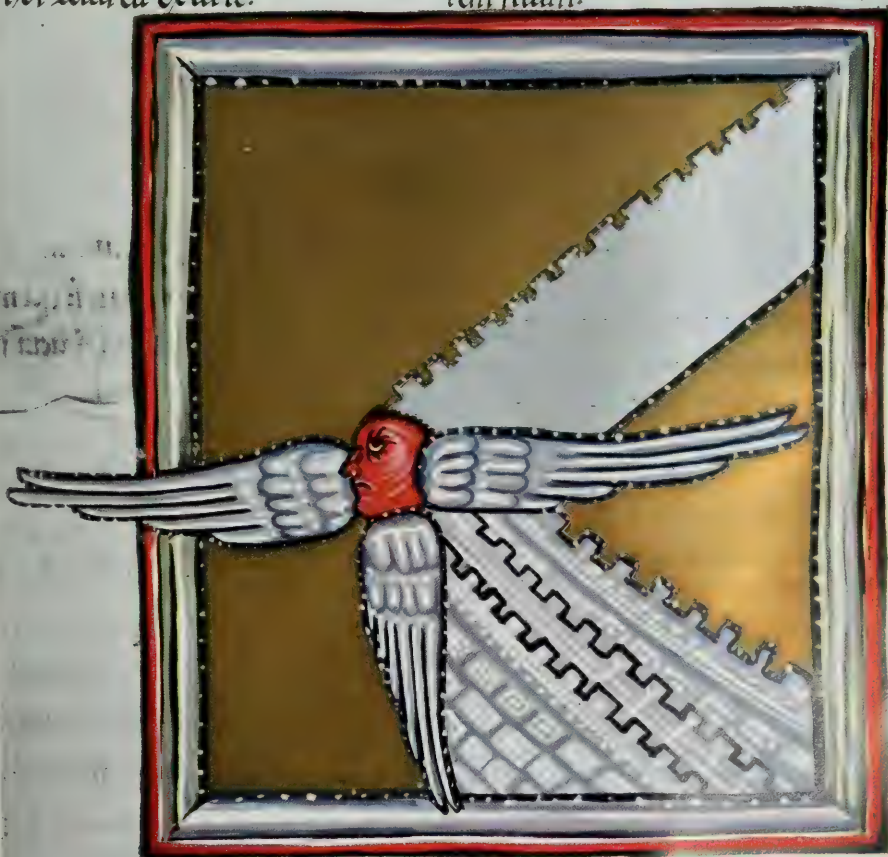


SEDENS LUCIDUS

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Ita iudicia eleuat. qm
 hos zelus di exurit.

hui. debet musicare cont^a creato
 rem suam.





repeated complete recoveries, her activity between the attacks, and the great age to which she lived. At first sight, the long procession of figures and visions suggests that she might have been the victim of a condition similar to that of which Jerome Cardan has left us so complete a personal record. But on reading the books of visions, the reader will easily convince himself that we are not here dealing with a dream-state. The visions are indeed essentially vivid. 'These visions which I saw', she repeatedly assures us, 'I beheld neither in sleep, nor in dream, nor in madness, nor with my carnal eyes, nor with the ears of the flesh, nor in hidden places; but wakeful, alert, with the eyes of the spirit and with the inward ears I perceived them in open view and according to the will of God. And how this was compassed is hard indeed for human flesh to search out.'¹

Nevertheless, though the visions exhibit great originality and creative power—the reader will often be reminded of William Blake—all or nearly all present certain characters in common. In all a prominent feature is a point or a group of points of light, which shimmer and move, usually in a wavelike manner, and are most often interpreted as stars or flaming eyes. In quite a number of cases one light, larger than the rest, exhibits a series of concentric circular figures of wavering form; and often definite fortification figures are described, radiating in some cases from a coloured area. Often the lights gave that impression of *working*, boiling or fermenting, described by so many visionaries, from Ezekiel onwards.

This outline of the visions the saint herself variously interpreted. We give examples from the more typical of these visions, in which the medical reader or the sufferer from migraine will, we think, easily recognize the symptoms of *scintillating scotoma*. Some of the illuminations, here reproduced in their original colours, will confirm this interpretation.

'I saw a great star most splendid and beautiful, and with it an exceeding multitude of falling sparks which with the star followed southward. And they examined Him upon His throne almost as something hostile, and turning from Him, they sought rather the north. And suddenly they were all annihilated, being turned into black coals . . . and cast into the abyss that I could see them no more'² (Plate XXI).

¹ Migne, col. 384.

² *Scivias*, lib. iii, vis. 1; Migne, col. 565.

This vision, illustrated by the beautiful figure of stars falling into the waves, is interpreted by her as signifying the *Fall of the Angels*.

The concentric circles appear in numerous visions, and notably in that of the *Days of the Creation of the World and the Fall of Man*, illustrated by what is perhaps the most beautiful of all the miniatures of the Wiesbaden Codex B (lib. ii, vis. 1, Plate xxii). It is in this concentric form that Hildegard most frequently pictures the Almighty, and the idea again appears in the eleventh miniature, here reproduced in its original colours, which she describes as 'a most shining light and within it the appearance of a human form of a sapphire colour which glittered with a gentle but sparkling glow' (lib. ii, vis. 2, Plate xxiii). Appearances of this type are recorded again and again.

The type with fortification figures is encountered in a whole series of visions, of which we reproduce the account and illumination of the *Zelus Dei* (lib. iii, vis. 5, Plate xxiv, lower section).

'I looked and behold a head of marvellous form . . . of the colour of flame and red as fire, and it had a terrible human face gazing northward in great wrath. From the neck downward I could see no further form, for the body was altogether concealed . . . but the head itself I saw, like the bare form of a human head. Nor was it hairy like a man, nor indeed after the manner of a woman, but it was more like to a man than a woman, and very awful to look upon.

'It had three wings of marvellous length and breadth, white as a dazzling cloud. They were not raised erect but spread apart one from the other and the head rose slightly above them . . . and at times they would beat terribly and again would be still. No word uttered the head, but remained altogether still, yet now and again beating with its extended wings.'

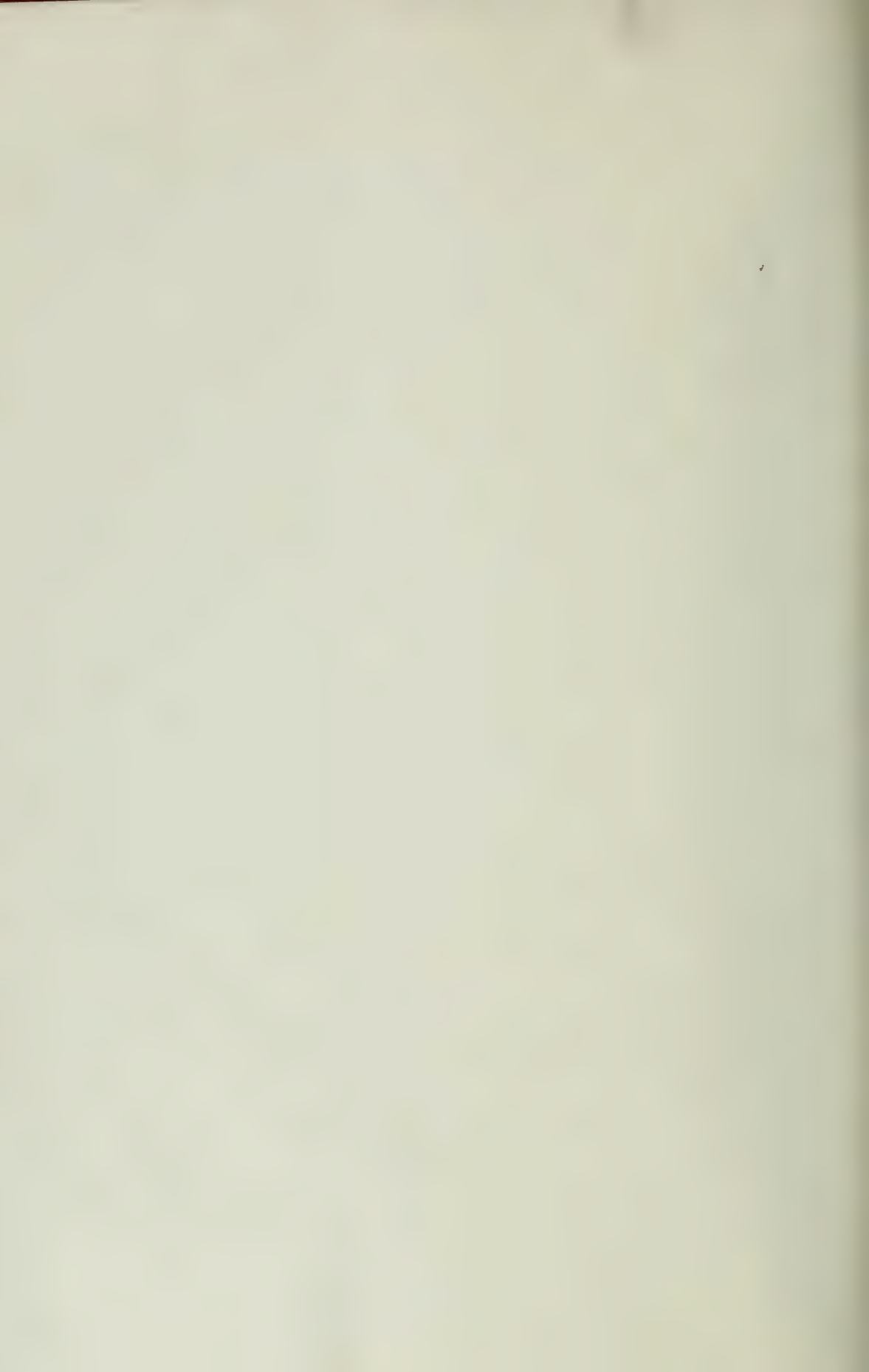
From the head extended a series of fortification lines, and this peculiar form of vision is reproduced on several occasions and variously interpreted (Plate xxiv, upper section). It is united with similar visions in what we regard as a reconstructed conception of exceedingly complex structure. This she claims to see separately, and she interprets it as the *aedificium* of the city of God (Plate xxv). Such reconstructed visions are clearly of a different type and origin to the simple group in which a shining light or group of lights is encountered and interpreted as a speaking figure.

v. Q. ^a factus est nullus est unum mundum
secundum tempus ordinatum a patre.
ut proficeret uoluntate n...

seruari potest.



Plate XXV. THE HEAVENLY CITY



Hildegard's visions, perhaps without exception, contain this element of a blinding or glittering light, which she interprets in a more or less spiritual manner. We terminate our account with the passage in which she sums up her experiences of it.

'From my infancy', she says, 'up to the present time, I being now more than seventy years of age, I have always seen this light in my spirit and not with external eyes, nor with any thoughts of my heart nor with help from the senses. But my outward eyes remain open and the other corporeal senses retain their activity. The light which I see is not located but yet is more brilliant than the sun, nor can I examine its height, length, or breadth, and I name it the "cloud of the living light". And as sun, moon, and stars are reflected in water, so the writings, sayings, virtues, and works of men shine in it before me. And whatever I thus see in vision the memory thereof remains long with me. Likewise I see, hear, and understand almost in a moment and I set down what I thus learn. . . .

'But sometimes I behold within this light another light which I name "the Living Light itself". . . . And when I look upon it every sadness and pain vanishes from my memory, so that I am again as a simple maid and not as an old woman.¹ . . .

'And now that I am over seventy years old my spirit according to the will of God soars upward in vision to the highest heaven and to the farthest stretch of the air and spreads itself among different peoples to regions exceeding far from me here, and thence I can behold the changing clouds and the mutations of all created things; for all these I see not with the outward eye or ear, nor do I create them from the cogitations of my heart . . . but within my spirit, my eyes being open, so that I have never suffered any terror when they left me.'²

¹ Migne, col. 18.

² Migne, col. 18.

NOTE.—The author's thanks are due to the Rev. H. A. Wilson, Mr. C. C. J. Webb, and Mr. R. R. Steele, who have read the proofs of this article and have made valuable suggestions; to Mr. J. A. Herbert of the MS. Department of the British Museum, who drew his attention to the work of Herrade de Landsberg; and to Mr. M. H. Spielmann, who brought to his notice the crucifix figured in Plate X. He owes a special debt of gratitude to the late Dom Louis Baillet of Oosterhooft for his courtesy and generosity in lending him reproductions of the illuminations of the Weisbaden Codex. Baillet was a young scholar of great promise, whose early death is a severe loss to the knowledge of mediæval science.

The author has also to thank Professor Henrici of the Nassauische Landesbibliothek at Weisbaden, Professor Wille and Professor Sillib of the Universitätsbibliothek at Heidelberg, and Signor Boselli of the R. Biblioteca Governativa at Lucca, who have all given him exceptional facilities for the study of the treasures under their charge.



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J. M. Robinson

JOHN WILFRED JENKINSON

John Wilfred Jenkinson was born in 1871, and came from Bradfield to Exeter College, Oxford, with a classical scholarship in 1890. After taking his degree in *Literae Humaniores* he came, in 1894, to University College, London, where he devoted himself with extraordinary and never-flagging energy to biological studies.

Without having had the usual preliminary scientific teaching, he brought, on the other hand, a well-trained mind to bear on his new work, and the rapidity and completeness with which he acquired his scientific equipment was one of the most striking and interesting points in his career. Jenkinson very soon turned to original investigation, and from the first he showed a predilection for Embryology.

For a short time he held a post at one of the great London hospitals, but he soon returned to Oxford to join the teaching staff of the Department of Comparative Anatomy. He used the opportunity of University vacations to work in the laboratory of the late Professor A. A. W. Hubrecht at Utrecht, where part of his first published research was written. During the fifteen years of life that remained to him, he established himself as the foremost English writer on Embryology, devoting himself especially to its experimental aspect, a line of work in which he will rank as one of the pioneers.

Jenkinson became Doctor of Science in 1905, and in the same year he married Constance Stephenson. In 1906 he was appointed University Lecturer in Embryology, and in 1909 he was elected to a Research Fellowship at Exeter College.

Jenkinson's mind was not of the type that matures early, but one felt in him a power of solid intellect that gained in force from year to year. The gap in the ranks of British Science caused by his death has been generally recognized, but his loss seems greatest to those personally acquainted with him, who know that he had by no means reached the zenith of his powers.

Jenkinson led a single-minded and unselfish life, wholly free from worldly and ignoble ambitions. Of simple and winning humour, happy in his domestic life and absorbed in his studies, he represented the very best type of scientific worker.

He was gifted with a powerful physique, and on the outbreak of war he became an ardent member of the Oxford Volunteer

Training Corps. His qualities of calm courage and high sense of duty marked him out as a valuable officer. Although forty-three years of age, he took a commission in the 12th Worcester Regiment in January, 1915, and was promoted Captain in the following April. On May 10 he left for the Dardanelles, having been selected for service with the 2nd Royal Fusiliers. He was killed in action on June 4, only ten days after his arrival at the Gallipoli peninsula.

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VITALISM

BY J. W. JENKINSON

IN one of the oldest biological treatises in the world, the soul or life of an organism is defined in the most general way as an activity of a natural organic living body—*ἐντελέχεια σώματος φυσικοῦ ὀργανικοῦ δυνάμει ζωῆν ἔχοντος*—life being autonomous nutrition and growth and decay. The activity may, however, be latent or patent, passive or active, sleeping or waking, without losing its peculiar characters. It is substance (*οὐσία*), but substance as ‘form’ as opposed to the material substance of the body, and the living body is therefore also a substance in a double sense.

It is not identical with the body; but as form, proportion (*λόγος*), activity (*ἐνέργεια*), essence (*τὸ τί ἦν εἶναι*), it is related to the body, mere matter (*ὑλη*), and potentiality (*δύναμις*) in just the same way as the seal is related to the wax; and the body is the instrument whereby it effects its purposes; though subsequent in time, it is prior in thought to the body, as all activities are to the materials with which they operate.

At the same time neither it nor its parts are separable from the body, with the exception, possibly, of mind (*νοῦς*); it is indeed the actual or possible functioning of the body, like the seeing of the eye or the cutting of the axe, and with the disappearance of the capacity of this functioning the soul itself also perishes. Lastly, it is a cause (*ἀρχὴ καὶ αἰτία*) in a triple sense: first, as the source of motion; secondly, as that for the sake of which the body exists; and thirdly, as its essence (*οὐσία*) or formal cause. The soul or life is of several kinds, which form together an ascending series each member of which is necessarily involved in those above it.

The lowest is the nutritive soul (*θρεπτικὴ*), found in all living things, and the only soul possessed by plants. It is defined as motion in respect of nutrition, decay, and growth, processes which involve alteration (*ἀλλοίωσις*) in the body; and its functions (*ἔργα*) are to utilize food for the maintenance and reproduction of the form of the body, and to control and limit growth.

The second is the perceptive soul (*αἰσθητικὴ*), the possession of which distinguishes animals from plants. This also is a kind of alteration (*ἀλλοίωσις τίς*) and consists in being moved and affected. The fundamental and indispensable perception is touch (*ἅφῃ*), for it is concerned in the acquisition of the food. It is invariably present: the others may or may not, some or all, coexist with it.

Thirdly, some animals are possessed of a capacity for locomotion, and the performance of this function requires again a special kind of soul.

Lastly, there is the reasoning soul (*διανοητικά*) or mind (*νοῦς*). This is found in man alone, unless there be other beings similar to him, or even nobler than he. Mind alone is eternal and separable from the body.

Though the observation and experiment of modern science would doubtless find much to alter in the details of these simple definitions, yet it must be conceded that, by what is certainly a most fortunate guess if it is not the most wonderful insight, Aristotle has laid his finger on the cardinal point of modern physiological doctrine. For, putting aside for the moment the mental faculties, it is here laid down in the clearest manner that not only the functions of growth and decay, nutrition, and reproduction, but also the capacity of responding to stimuli are to be ultimately resolved into some kind of movement of the particles of which the body is composed. Life, in short, as we might say with Virchow, is a mode of motion.

The biology of to-day distinguishes living from inanimate bodies by the possession and exercise of the three principal properties or functions of metabolism, irritability, and reproduction; and further, the body which performs these functions is not only composed of chemically complex substances—proteids—which are not found in things that are not alive, but possesses a structure. In no case, even the simplest, is the organism a mere homogeneous lump of protoplasm, but it has parts or organs, visibly different from one another, and obviously correlated with the activities appropriated to each; and it is the preservation of that structure, in the individual and in the race, which is the end towards which the collective performance of all these functions, or the life of the organism, is apparently directed.

Some of these peculiarities are shared by certain things that are not commonly regarded as alive. Crystals have of course a definite

structure; they can divide, and when broken they can make good the missing part, but they do not assimilate to the substance of their own bodies a food-material which is less complex than it, and they are not irritable.

The differences, indeed, between the living and the lifeless are so profound, that it is not to be wondered at that there should have been in all ages natural philosophers who have held that living activities are phenomena *sui generis*, differing *toto caelo* from the properties exhibited by lifeless bodies, and never by any conceivability to be expressed in terms of these.

— This doctrine is vitalism.

It exists in several varieties, but one at least is of very ancient lineage and can be traced back through mediæval times to the biological speculations of the Greeks.

Whether Aristotle really held the vitalistic views which have since been attributed to him is a matter we shall have to discuss later on, but it is certain that in the writings of Galen there is to be found a theory of life which bears the stamp of Aristotelian influence, and was destined to hand that influence on to future generations. Galen admits the sensitive soul of Aristotle as the peculiarity of animals, and the rational soul for man, but substitutes for the nutritive soul certain works of nature—attraction, repulsion, retention, alteration. And further, the rational soul is no longer immortal, but perishable, and is dependent on the body, where its seat is in the brain; it is material or quasi-material, a *πνεῦμα*, most efficient when dry.

After a long interval this doctrine reappears in the sixteenth century in the writings of Vesalius, who tells us that the heart has a vital soul, the liver a natural soul, while there is elaborated in the ventricles of the brain an animal spirit or principal soul.

Meanwhile, however, the conception of life as something material had been discarded by Paracelsus for the belief that the soul, or as he called it, the 'Archæus', by which the chemical processes of the body are governed, is not a material but a spiritual force, a view restated by Stahl more than a hundred years afterwards. 'The events of the body', says this author, 'may be rough-hewn by chemical and physical forces, but the soul will shape them to its own ends, and will do that by its instrument, motiçn.'

This, of course, is vitalism, and vitalism in its extreme or 'animistic' form. The idea recurs later on in the biology of

Treviranus. To be living is to have a soul, he tells us, and the conscious *Lebenskraft* employs the forces of the material world to form the organism. 'Das Weizenkorn hat allerdings Bewusstsein dessen, was in ihm ist und aus ihm werden kann, und träumt wirklich davon.' Though he adds quaintly enough, 'Sein Bewusstsein und seine Träume mögen dunkel genug sein'. It is curious to observe the revival, at the beginning of the twentieth century, of this mediaeval mysticism in the speculative writings of so accomplished an experimentalist as Hans Driesch.

Driesch is an embryologist who in his earlier days had enunciated an invaluable analytical theory of development, a theory which suggests that while the formation of the first or elementary organs that appear in the embryo or larva—such structures as the larval gut or sense-organ, or the germ-layers—depends upon the presence in the germ of certain specific organ-forming substances (and this is a fact which has since been abundantly demonstrated by experiment), the origin of parts that appear later in development may be accounted for by the action of the first-formed structures upon one another, these actions being in the nature of physiological responses to stimuli; and for this also some evidence has been produced. On this view differentiation is a mechanical process, set in motion by fertilization or some other cause, and, given a certain initial structure of the germ or ovum, given the presence in it of a certain number of parts or substances capable of acting upon one another with a fixed co-ordination or harmony of the stimuli and the responses, given further a proper constitution of the external environment, then a definite result must follow, the production of an organism which is like the parents that gave it birth.

But in his later treatises this hypothesis has been repudiated, and, by a remarkable *volte-face*, replaced by a dogma of a wholly different kind. For now it is urged that no merely material factors can possibly account either for the harmony of development—the due co-ordination of mutually reacting parts; or for the secondary harmony of composition—the formation of complex organs by the union of tissues; or for the functional harmony seen in the activities of the adult.

For example, it is asserted that any fragment of an egg of a sea-urchin, if not too small (not less than $\frac{1}{32}$ of the egg), can give rise to a whole and normal larva. We are told that the cells of the segmented ovum may be disarranged to any extent by various

means, such as raising the temperature, diluting the sea-water, removing the calcium from the sea-water, or by shaking, without prejudice to the ultimate normality of development. Each part of the ovum can therefore, according to the needs of the case, give rise to any part of the resulting organism. 'Jeder Teil kann nach Bedürfniss jedes.'

And thirdly, when the gastrula of a sea-urchin is transversely divided into two, each half, it is stated, develops into a diminished whole larva in which the gut becomes divided into the characteristic three regions, and all the other organs are formed in correct proportion.

For each of these acts of development in the whole uninjured larva an explanation may conceivably be given in terms of formative stimuli exerted by the originally distinct parts of the egg and calling forth responses in other parts. A mechanism may be thought of which, when set in motion, will achieve a certain end in accordance with its own pre-established harmony; but a mechanism which can be subdivided *ad libitum*, or almost *ad libitum*, and the parts of which will still achieve the same end, will still behave as wholes with their parts co-ordinated in the same ratio, temporally and spatially! Such a mechanism is inconceivable; for to ensure the uniform result, the relative amounts and positions of the necessary substances must be imagined as identical in every possible fragment of the egg that is not too small. Something is therefore required to superintend, to co-ordinate the causes of development in the case not only of the part but of the whole egg as well; and this something is not material. A corroborative proof of the inadequacy of the purely material explanation—the causal explanation in the ordinary sense of the phrase—may be derived from a consideration of certain other vital processes. The facts of acclimatization and immunity betray an extraordinary adaptability of the organism to a change in its environment; an organ will adapt itself structurally to an alteration, quantitative or qualitative, of function [Roux's 'Functional Adaptation']; lost parts can be regenerated; and then there is the physiology of the nervous system.

In all these cases of 'regulation'—and indeed in all other responses to stimuli—the same element, inexplicable in chemical and physical terms, exists and must exist in development. This entity is not a form of energy, but a vital constant, analogous to

the constants or ultimate conceptions of mechanics and physics and chemistry and crystallography, but not reducible to these, just as these cannot be translated into one another.

Driesch describes it as a rudimentary feeling and willing, a 'psychoïd', 'morphaesthetic' or perceptive of that form which is the desired end towards which it controls and directs all the material elements of differentiation, like the grain of wheat of Treviranus, dreaming dimly of its destiny. It is thus a *vera causa*—an unconditional and invariable antecedent—a psychological factor which can intervene in the purely physical series of causes and effects, and for it he revives the Aristotelian term 'Entelechy'.

Such is the 'vitalism' introduced by Hans Driesch, a teleological theory clearly, but no mere metaphysical doctrine of final causes: rather a dynamic teleology which not only sees an end in every organic process, but postulates an immaterial entity to guide the merely mechanical forces towards the realization of that end.

Such a theory is open to very serious criticism from both the scientific and the philosophical side. But before we pass to that criticism let us turn aside to examine some of the other aspects under which the Proteus of Vitalism presents himself.

Thus the modern physiologist Bunge, while owning that it would be a lack of intelligence to expect to make with our senses discoveries in living nature of a different order to those revealed to us in inorganic nature, yet insists that we must transfer to the objects of our sensory perception, to the organs, to the tissue elements, and to every minute cell, something which we have acquired from our own consciousness, something, that is to say, which is not motion, and is not in space, but is in time only.

The essence of vitalism, so Bunge would have it, lies in starting from what we know, the internal world, to explain what we do not know, the external world. We can only remark that this position appears to rest upon an epistemological confusion, for Bunge has evidently failed to distinguish between the idealism which teaches that the world of nature, including our own bodies, only exists in so far as it is an object of knowledge, that reality is ultimately ideal, and the 'animism' which, as we have seen, gives every object, at least every living object, in nature a directive consciousness of its own. The former does not lie immediately within the scope of the present inquiry; the latter we shall have occasion to discuss again.

How far the tenets of animism are to be attributed to Johannes Müller is not very clear. For while Müller maintained that an organism is due to an idea which regulates its structure, is the cause of its harmony, and is in action in the organism itself, exerting on it a formative power, yet he held that the process was unconscious. Müller indeed distinguished explicitly between the vital and the mental or conscious principle, for in the operations of the former the manifestation of design is the result of necessity, not of choice. At the same time the two resemble one another in being homogeneous, in existing throughout the mass of the organism which they animate, and in being divided together with the organism (as in regeneration) without suffering any diminution or change of their powers.

In this conception of the unconscious idea there may possibly be some confusion between the formal and the final cause, between the idea of the end to be realized, present at the beginning in the mind of the artificer, and the end itself. The former is animism; the latter is sound enough as metaphysics, but is not science at all.

There is still another school of vitalists which, while not going so far as to commit itself to a belief in a 'psychoid', yet proclaims in no uncertain voice the autonomy of the organism, and not content with the assertion that at present we have not succeeded in reducing the activities of the organism to chemical, physical, and mechanical processes, maintains the utter futility of such endeavour, and pronounces over the hidden mysteries of life an eternal *Ignorabimus*.

Some such view as this we must, I think, attribute to Dr. Haldane. 'In biology', he says, 'the phenomena which are or ought to be observed from the very beginning are not physical and chemical phenomena as self-existent events, but these phenomena as expressions of the activity of living organisms. It is the living organism, and not the physical phenomenon, which is the reality for biology.' His belief in organic autonomy is based on the physiology of metabolism, secretion and absorption, the circulation of the blood, and the nervous system. Thus in discussing the blood, after pointing to the constancy in its volume and composition, he proceeds: 'Neither starvation nor ingestion of food and drink materially affect it: liquid injected into it is got rid of with remarkable rapidity; and any loss of blood by bleeding is soon replaced. This vital metabolism of the circulatory system is doubtless due

chiefly to the activity of its lining endothelium, which most certainly does not play the mere mechanical part which has often been attributed to it. The other so-called "mechanisms" can likewise be shown to have all the characteristics of the living body, inasmuch as they actively maintain their structure, just as the organism as a whole does so. There is thus no warrant for calling them mechanisms, and thus ignoring what is one of their essential characteristics.' In passages such as these we seem to catch an echo of Müller's unconscious idea, and again we ask ourselves, Are we dealing with a final or a formal cause? Indeed, Dr. Haldane insists that his ground conception is teleological.

There is still one other vitalistic theory to which we must allude, although its interest is now merely historical. This is the belief in a special vital material, unlike the material of which lifeless bodies are composed, and endowed with a special vital force, different from but co-ordinate with the forces of mechanics and physics.

In his *Histoire Générale des Animaux* Buffon, after referring to the obvious peculiarities of animals and vegetables—that their actions are directed to an end, the conservation of a durable species—proceeds to elaborate a thesis in which it is held that they are composed of organic germs, and that germs of the same kind are distributed throughout nature, lifeless as well as living. When an animal or plant dies, its body is dissolved into these germs, which are then scattered abroad; when it assimilates, it is by separating these ubiquitous particles from the brute inorganic portion of the food. The former is utilized for its own growth, the latter it gets rid of by evacuation and excretion. Lifeless matter is therefore never converted into living material.

Another advocate of the doctrine of a vital force, a property of the tissues of the body, and at perpetual war with those inorganic forms which tend to their destruction, was the physiologist Bichat. Such a conception as this could not of course survive the rise of modern chemistry. Its death-knell was sounded when Lavoisier and Laplace showed that the bodies of organisms were composed of the same elements as are found in inanimate nature, and it has long since passed into the limbo of discredited speculations.

Apart from this, vitalistic theories would appear to be in the main of two kinds.

First, there is the metaphysical vitalism which tells us we can never explain the living in terms of the lifeless, insists on the per-

manent separation of the sciences of biology on the one hand from chemistry and physics on the other, and preaches the autonomy of the organism without venturing to tell us in what that autonomy consists.

Secondly, there is the psychological theory of animism which posits an autonomous psychical entity to preside over the chemical and mechanical operations of the body, whether already formed or in process of development, and to direct them towards its own ends, the conservation and reproduction of that body's specific form.

A third party, halting between two opinions, suggests an unconscious idea, without, however, clearly explaining whether this is to be taken in a metaphysical or a psychological sense. Frankly opposed to vitalism in all its forms is the conception of the living body as a mechanism. This has also an honourable ancestry behind it. How far the biology of Aristotle is to be looked upon as mechanistic we shall presently have to inquire, but in Galen the soul is certainly material, or quasi-material, as we have already observed. It is, however, in the physiology of Descartes that mechanism first appears unmistakably in its modern guise.

For Descartes the body is simply an earthly machine. The nerves are tubes up which—in sensation—the animal spirits flow to the brain only to be reflected (whence our term reflex action) down other tubes to the muscles.

'All the functions of the body', he tells us, 'follow naturally from the sole disposition of its organs, just in the same way that the movements of a clock or other self-acting machine or automaton follow from the arrangement of its weights and wheels. So that there is no reason on account of its functions to conceive that there exists in the body any soul, whether vegetative or sensitive, or any principle of movement other than the blood and its animal spirits agitated by the heat of the fire which burns continually in the heart and does not differ in nature from any of the other fires which are met with in inanimate bodies.'

The rational soul, the soul which thinks, that is, understands, wishes, imagines, remembers, and feels, is not material. Yet it always acts through the machine, though that machine can go on perfectly well without the soul. 'When the body has all its organs properly arranged for a particular movement it has no need of the soul to carry them out. All movements, even those which we call voluntary, depend principally on the same disposition of the organs.

One and the same cause renders the dead body unfit to produce the movements and leads the soul to quit the body.'

The biology of Descartes appears to have been accepted by contemporary physiologists like van Helmont and Borelli, and certainly commended itself to another philosopher of eminence, Leibnitz. Like Descartes, Leibnitz also affirms that the body is a machine or natural automaton; unlike Descartes, however, he refuses to believe that the mind directs the machine in any way. Rather there is a complete series of psychical parallel to a complete series of physical events, and between the two a pre-established harmony.

Although the details of Cartesian physiology have long since been exploded, yet the mechanical principle which that philosophy enunciated so clearly has persisted and has indeed proved to be the rock on which modern physiological science has been built. For, when once the chemists had discovered animal and plant structure to be composed of elements found in lifeless bodies, and had proved that compounds found only in the organism could yet be synthesized *in vitro*, there was no longer any reason why the properties of the compounds should be considered as of a different order to the properties of their component elements. A method applicable to one was applicable to the other, and as Claude Bernard has put it, mechanical, physical, and chemical forces are the only effective agents in the living body, and they are the only agencies of which the physiologist has to take account.

The substances of which the living body is made up are no doubt extremely complex, yet none the less—to quote a more recent writer, Verworn—'physiology is in the last resort the chemistry of the proteids'. This is the principle that has now for nearly a century guided and stimulated research into the functions of the organism: to this principle physiologists, too numerous to name, have not been ashamed to subscribe: under its banner some of the proudest triumphs of the science have been won. Yet it is precisely this which modern or neo-vitalism has challenged and asks us to relinquish in favour of a theory of psychoids or a pseudo-metaphysical view of life.

The vitalistic position may be assailed from two points, the scientific and the philosophical.

In the first place the vitalist asserts that mechanism is inadequate to explain the phenomena of metabolism, of transmission of

nervous stimuli, or of development. It is upon the last of these that Driesch lays special stress.

He has urged, as we have seen, that although a mechanical explanation might be given (such an explanation has indeed been put forward by himself) of the specific differentiation of the organism by supposing the first-formed elementary organs, developed out of the substances given in the initial structure of the germ, to act and react upon one another in accordance with a certain harmony, provided for by the same structure; yet a mechanism which can be subdivided *ad libitum* or almost *ad libitum*, and each part of which will still give rise to a complete organism, is not to be conceived. The answer to this objection has, however, been supplied by the experiments of Driesch himself and of many others. For though it is true that each of the first two, four, eight, or even in some cases each of the first sixteen cells into which the fertilized ovum becomes segmented, can, when separated from its fellows, give rise to a complete organism, yet in all cases there comes a time when the parts cease to be totipotent and produce not whole but partial structures.

This invariable restriction of potentialities, which occurs earlier in some cases than in others, and is not due to mere deficiency of substance, is not hard to account for.

Those substances on the presence of which in the ovum, as experiment has taught us, the formation of the elementary organs of the embryo or larva depends, are arranged in different cases in different ways: and they certainly may be, and very frequently are, so distributed that while each of the first four cells contains a like quantity of each of these specific substances, arranged in it exactly as they were in the whole ovum, the next division will sunder these materials in such a way that of the resulting eight blastomeres four will have more of one of the primary egg-substances, less of another; the amounts apportioned to the other four being in just the inverse ratio of this: and the result will be a difference in the fate of the cells when they are isolated from one another. In those of the one group the proportions of the organs developed out of these substances will not be the same as they are in the other. This is precisely the result which experiment has revealed; it is exactly this result which Driesch has ignored, or rather attempted to explain away.

It is evident, then, that to some extent the parts of this

mechanism are interchangeable, that it can be subdivided, and that each part, brought now under new conditions, will still possess the potentialities of the whole, just as such a mechanism as a rocket, out of which, under the appropriate stimulus, a certain pattern of stars is developed, might be subdivided into two or more rockets of half size or less. There is, however, a limit to this interchangeability, while if the subdivision be carried beyond a certain point the totipotence of the parts is lost.

If the number of these organ-forming substances given in the germ were very large, as large, let us suppose, as the total number of separately inheritable characters, it might indeed be difficult to imagine a mechanism divisible into even two totipotent parts. But from the need for this assumption we are saved by the second part of Driesch's own *Analytische Theorie*, which accounts for subsequent processes of differentiation by attributing the production of new parts to the mutual interactions of those that are the first to appear. For this also experimental evidence, though meagre, is not lacking, while a close parallel is found in the dependence of certain bodily functions upon substances—the hormones of Professor Starling—secreted by other organs.

In the second place the vitalist maintains that the processes of metabolism defy, nay more, always will defy, chemical and physical analysis. The first part of this statement may be a true description of the knowledge of to-day, but the existence in the living body of the same elements as are met with elsewhere, the synthesis of complex organic substances, the establishment of the equivalence of the energy which leaves the body as mechanical work or heat to that which enters it in chemical form in the food, should surely make us hesitate before abandoning all hope of attaining to a chemistry of life.

And thirdly, there are physiologists who believe that the complex phenomena presented to us in the activities of the nervous system are susceptible of a purely mechanical explanation.

'A feature', says Gotch, 'which more particularly suggests spontaneous cellular activity is the well-known fact that centrifugal discharges may continue after the obvious centripetal ones have ceased. This is pre-eminently the case when the central mass is rendered extremely unstable by certain chemical compounds, such as strychnine, &c. There are, however, suggestive indications in connexion with such persistent discharges. The more completely

all the centripetal paths are blocked by severance and other means, the less perceptible is such persistent discharge, and since nervous impulses are continually streaming into the central mass from all parts, even from those in apparent repose, it would seem that could we completely isolate nerve-cells, their discharge would probably altogether cease.' Even in the hyper-excitable condition produced by strychnine the spinal motor nerve cells do not discharge centrifugal impulses when cut off from the centripetal connexions. The physiologist, therefore, has 'definite grounds for believing that, as far as present knowledge goes, both the production and cessation of central nervous discharges are the expression of propagated changes and that these changes reveal themselves as physico-chemical alterations of an electrolytic character. The nervous process, which rightly seems to us so recondite, does not, in the light of this conception, owe its physiological mystery to a new form of energy, but to the circumstance that a mode of energy displayed in the non-living world occurs in colloidal electrolytic structures of great chemical complexity.'

To all these considerations we must add the fact that life did once originate upon this planet from matter which was not alive, and that even now some inorganic phenomena present at least remote analogies with certain vital processes. Such are the structure, the spontaneous division, and the regeneration of crystals.

We turn now to the philosophical objections that may be raised to vitalistic speculations; and here we must be careful to distinguish what we may term the psychological from the metaphysical form of the theory.

Driesch has maintained that the belief in a morphaesthetic psychoid finds support in the philosophies of Kant and Aristotle. Let us examine the merits of this claim.

Like the scientists of to-day, Kant, in his *Critique of the Teleological Judgement*, lays it down as a rule that the mechanical method, by which natural phenomena are brought under general laws of causation and so explained, should in all cases be pushed as far as it will go, for this is a principle of the determinant judgement. There are cases, however, in which this alone does not suffice. The possibility of the growth and nutrition, above all of the reproduction and regeneration of organisms, is only fully intelligible through another quite distinct kind of causality, their purposiveness. Organisms are not mere machines, for these have simply

moving power. Organisms possess in themselves formative power of a self-propagating kind, which they communicate to their materials. They are, in fact, natural purposes, both cause and effect of themselves, in which the parts so combine that they are reciprocally both end and means, existing not only by means of one another but for the sake of one another and the whole. The whole is thus an end which determines the process, a final cause which brings together the required matter, modifies it, forms it, and puts it in its appropriate place. Such purposiveness is internal, for the organism is at once its own cause and an end to itself, not merely a means to other ends, like a machine whose purposiveness is relative and whose cause is external.

Such is the principle of the teleological judgement. It is a heuristic principle rightly brought to bear, at least problematically, upon the investigation of organic nature, by a distant analogy with our own causality according to purposes generally, and indispensable to us, as anatomists, as a guiding thread if we wish to learn how to cognize the constitution of organisms without aspiring to an investigation into their first origin.

Could our cognitive faculties rest content with this maxim of the reflective judgement it would be impossible for them to conceive of the production of these things in any other fashion than by attributing them to a cause working by design, to a Being which would be productive in a way analogous to the causality of intelligence. Natural science, however, needs not merely reflective but determinant principles which alone can inform us of the possibility of finding the ultimate explanation of the world of organisms in a causal combination for which an understanding is not explicitly assumed, since the principle of purposes does not make the mode of origination of organic beings any more comprehensible. And then, in a passage remarkable for its prophetic insight, Kant proceeds to show how this might be. This 'analogy of forms', he says, 'which with all their difference seem to have been produced according to a common original type, strengthens our suspicion of an actual relationship between them in their production from a common parent, through the gradual approximation of one genus to another—from those in which the principle of purposes seems to be best authenticated, that is from man down to the polype, and again from this down to mosses and lichens, and finally to the lowest stage of nature noticeable by us, namely, crude matter'.

And so the whole technic of nature, which is so incomprehensible to us in organized beings that we believe ourselves compelled to think a different principle for it, seems to be derived from matter and its powers according to mechanical laws like those by which it operates in the formation of crystals. A purposiveness must, however, be attributed even to the crude matter, otherwise it would not be possible to think the purposive form of animals and plants.

Although there are doubtless in the *Critique* many obscurities and inconsistencies, to which we cannot allude now, the general meaning of Kant's reflections upon organisms is perfectly clear. He who would 'complete the perfect round' of his knowledge must think not only in beginnings but in ends. The end in the case of a living being is apparently plain—it is the maintenance and reproduction of its form; the end in the case of the cosmic process is to be sought in the ethical, or, in Kantian phraseology, the 'practical' concept of the freedom of the moral consciousness of man.

Such a position is quite intelligible, philosophically, but the testimony it brings to the theory of the psychoid is of very doubtful value, as Driesch is well aware. He complains indeed that Kant's teleology is descriptive or 'static', rather than 'dynamic', as is perfectly true, except in the case of man, a point of which Driesch naturally makes the most. There are, no doubt, passages where Kant speaks of 'a cause which brings together the required matter, modifies it, forms it and puts it in its appropriate place'; but against these must be set the explicit statement 'that if the body has an alien principle (the soul) in communion with it, the body must either be the instrument of the soul—which does not make the soul a whit more comprehensible—or be made by the soul, in which case it would not be corporeal at all.' Vitalism can glean small comfort from this. Let us turn, then, to the second authority.

As we have seen already, the souls or functions of nutrition and perception are, in the Aristotelian biology, ultimately to be expressed as alterations or movements of the particles of the body; mind alone is separable from body and eternal.

In the development of the individual organism the mind comes in from outside, but the two souls of lower order are present in the σπέρμα, or κύημα, as Aristotle calls it, which results from the comingling of the male and female elements, or, as we should say, the fertilized ovum. The material and efficient causes of development are not, however, both contributed by each of the parents.

The teaching of Aristotle is that the matter is provided by the female and the female alone. The egg (or catamenia in mammals) is described as being mere matter (*ἔλλα*), body (*σῶμα*), potentiality (*δύναμις*), passive (*παθητικόν*) and merely quantitative, although it is true that a sort of soul, the nutritive, is somewhat grudgingly conceded to it, since unfertilized eggs appear in some sense to be alive. The male element, on the other hand, provides the principle of motion (*ἀρχὴ τῆς κινήσεως*) and the form (*εἶδος*); it is qualitative, it is activity, it produces the perceptive soul, if it is not itself that soul, and it is responsible for the 'correct proportionality' (*λόγος*) of the organization. The male element contributes only motion, but no matter; it acts upon the female element as rennet acts when it coagulates milk, except that the analogy is incomplete, since the *γονή* brings about a qualitative and not merely a quantitative change in the material on which it operates. To this it imparts the same kind of motion which itself possesses, the motion which was present in the particles of the food in its final form from which it was itself derived. The communication of this motion is enough to set going the machinery (*αὐτόματον*); the rest then follows of itself in proper order.

Lastly, the sperm of the male acts like a cunning workman who makes a work of art, using heat and cold as the workman uses his tools: for this heat and this cold could never of themselves—by coagulations and condensations—produce the form of the body as the older naturalists had supposed, regarding only the efficient and ignoring the formal and the final cause: for the organic body is not what it is because it is produced in such and such a fashion, rather it is because it is to be such and such that it must be developed as it is.

And here lies the kernel of the whole matter. For while Aristotle has made it perfectly plain that, according to his idea, the soul, at least its nutritive and perceptive faculties, is to be regarded as a function of matter and that this function may be ultimately expressed in terms of movement, and further that development is a mechanism which is set going by the communication of motion proceeding from the 'soul' of the male element and derivable eventually from the motions into which the 'functions' or 'soul' of the parent can be resolved to the mere matter which the female provides, it is equally evident that he does not regard this mechanical explanation—in terms of material and efficient causes—as satisfactory or complete. But when we inquire why, he gives us no

certain nor consistent answer. On the one hand, there are passages in which he tells us that there must be something which controls the material forces and imposes on them a limit and proportionality of growth ; that the soul makes use of them as the artist makes use of his implements, and such passages are naturally interpreted by Driesch in the sense of a 'dynamic' teleology ; it is the $\psi\upsilon\chi\acute{\eta}$ which superintends and controls, and the $\psi\upsilon\chi\acute{\eta}$ is 'entelechy'.

Elsewhere, however, we are informed that even the proportionality of the developing parts is simply the outcome of the motion imparted by the male, which is *actu* what the female element only is *potentia*.

Moreover, it may be questioned whether Aristotle ever intended to imply more than an 'analogy with the causality of purpose' when he uses the figure of the workman and his implements to illustrate his meaning of the formal cause. The formal cause of a work of art is an intelligible *vera causa* ; it is the idea in the mind of the artist antecedent to the execution of the work ; but the formal or final cause of an organism, the end which it apparently strives to attain, can only be said by a metaphor to be prior in time to the existence of the organism itself. Prior in thought, however, it certainly is, for it is only the performance of its functions ($\acute{\epsilon}\nu\tau\epsilon\lambda\acute{\epsilon}\chi\epsilon\iota\alpha$) by the organism complete in all its parts that makes the mere mechanism of development comprehensible to us ; the process, therefore, exists for the sake of the end. Only as efficient cause is the soul prior in time ; only so far as it is prior in thought can it be said to be a final cause.

Such a teleology is, it is obvious, indistinguishable in principle from the position in which Kant leaves us. It is the position adopted by Driesch himself in his earlier *Analytische Theorie*, but abandoned in the *Vitalismus* in favour of a theory of 'psychoids'.

Now quite apart from the meaning which Aristotle may or may not have intended to convey, there are grave objections to this belief. This 'psychoid', to which the name 'entelechy' is surely misapplied, this rudimentary feeling and willing, which is aware of the form it desires to produce, must be psychically at least as complex as the phenomena it is designed to account for, and stands, therefore, as much in need of explanation as they ; as Kant has observed, this will involve us at once in an infinite series of such entities. In fact it is only a photograph of the problem, and not a solution at all.

Again, when we ask what the *modus operandi* of this cause is, we get no reply either from Driesch or from any other neovitalist. The objection that the intervention of a psychical cause in a physical process is unintelligible, an objection which would probably appeal to many, may be waived, for in the last resort the connexion between any—even simple mechanical—causes and effects is equally hard to understand.

It may, however, be doubted whether these entities are not being multiplied beyond necessity, and whether the progress of science would not be better served by an adherence to a simpler philosophy. But even when it has discarded the psychoid we find vitalism still denying the possibility of mechanical explanation, still preaching the autonomy of the organism. The 'dynamic' teleology of Driesch has only disappeared to be replaced by the metaphysical doctrine of the final cause.

We may point out, perhaps, in passing, that the organism is by no means as autonomous as might be desired. The end towards which the creature strives, the maintenance and reproduction of its own specific form, is not a constant *terminus ad quem*, for species are as mortal as individuals: nor is it always achieved; the autonomy of a worm, which, bisected in a certain way, regenerates a tail instead of a head, or of a frog, which, after a particular injury, develops six legs instead of two, has surely renounced its rights. But, setting this aside, it must be seriously questioned whether any good purpose is served in biological discussion by decrying the value of mechanical conceptions or by confounding two distinct orders of thought. The questions are grave ones: for the issue at stake is no less than the existence of physiology as the science of the causes of living activities.

'Recte ponitur', said Francis Bacon, 'vere scire esse per causas scire.' The maxim of the great founder of modern inductive science has been the lode-star of biology in the past, and is still its watchword to-day. By exact observation and crucial experiment, utilizing every canon of induction, the activities of the living organism are to be brought under wide general laws of causation, which will be, in the first instance, physiological laws—of response to stimuli, of metabolism, and of growth: by means of these laws predictions can be made, and verified as often as we please. But no bar can legitimately be set to the scope of human inquiry; the thought process will not rest here, and ultimately it may be

possible to state the widest generalizations of biology in chemical and physical, and these again in purely mechanical terms. The maintenance and evolution of form in the individual, as well as the larger evolution of form in the race, become but the final terms in a far vaster cosmic process, from 'homogeneity to heterogeneity'.

The idea is, of course, perfectly familiar: it is the analysis of purely physical causes, carried to its extreme limit. Phenomena are thought out in terms not of origins merely, but of one origin, and that one origin is the only mystery that remains. This unification of the sciences has always been and must still remain the dream and the faith and the inspiration of the scientific man, and could such an edifice of the intellect ever be realized, the task of science would have been completed. Only when this purely deterministic method has been pushed as far as it will go does science leave off; only where science leaves off does philosophy begin.

There is an order of time, and there is an order of thought. Science works in the order of time, and necessarily so: for although science can never say what constitutes the invariable link between antecedent and consequent which it terms causal, yet it rightly speaks of the first as cause, determining the second as effect, since it is its function to predict from the past which is known to the future which is not.

But the outlook of philosophy is different. Dissatisfied with the endless regress of cause and effect, sceptical of first causes and original homogeneities, out of which by no conceivability could any heterogeneity have ever been developed, philosophy looks to the end.

The activities of living organisms at least appear to be directed to an end; they are apparently purposive, and it is this purposiveness which lends to biology, though built on the fundamental conceptions of chemistry and physics, peculiar features of its own, and is, of course, answerable for the teleological language which biologists so frequently employ. And by a knowledge of the end, the view of science, to which *qua* science it cannot too rigidly confine itself, will doubtless be supplemented and enlarged.

But, plain and definite though the end of an individual life may be, the end of the race—of the human or any other race—the end of the universe, are things only to be guessed at, and all we are left with is an indefinite series of evolving systems emerging out of an infinite past and fading into an infinite future.

In the final issue, indeed, the last effect is as delusive an *ignis fatuus* as the first cause. The philosophy which has rejected one must divest itself of the other, and seek its end, if anywhere, in the logical *prius* of the mind, which, though last in time, is yet first in thought, since through it alone can that ordered knowledge of nature which we call science be born and brought to perfection.

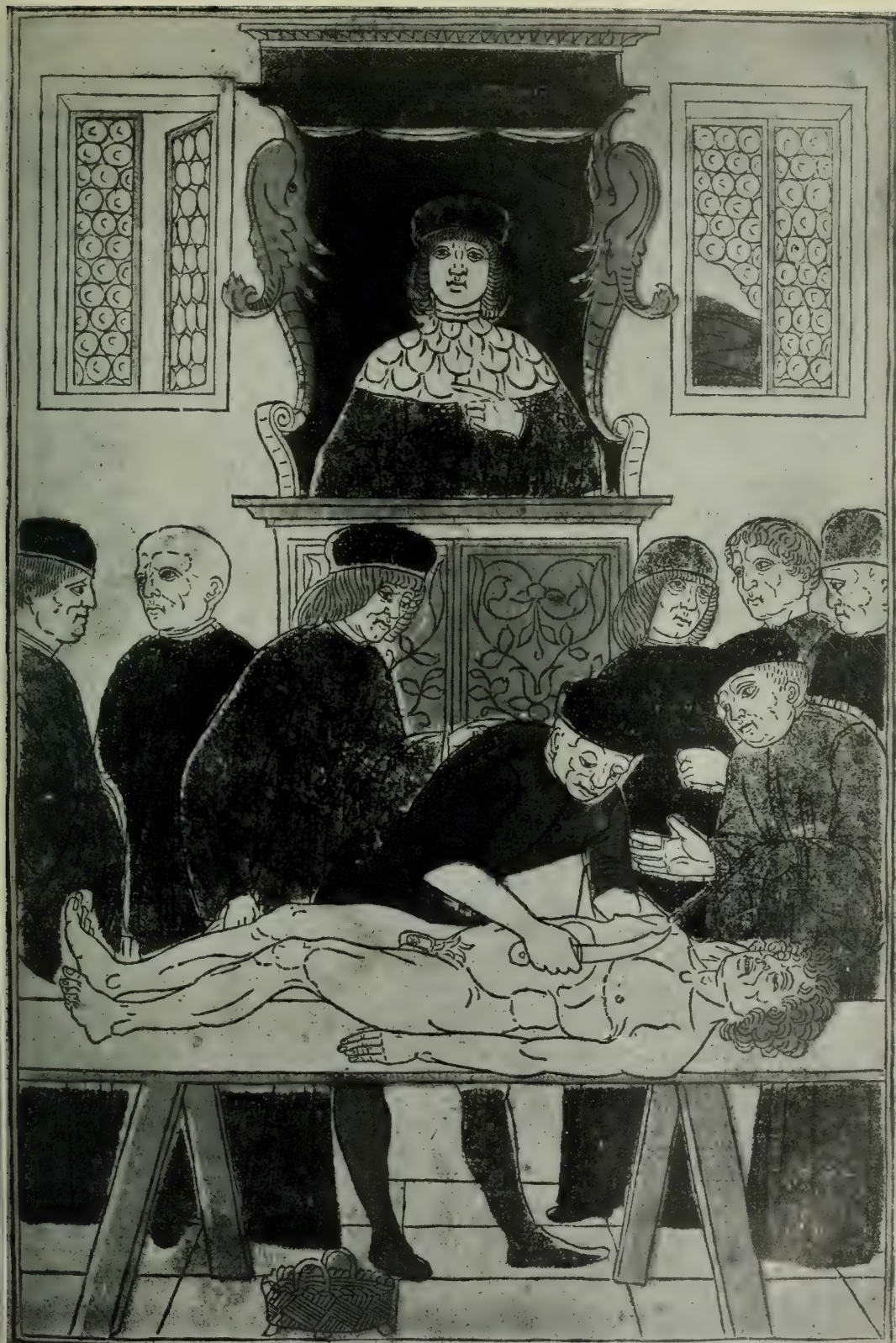
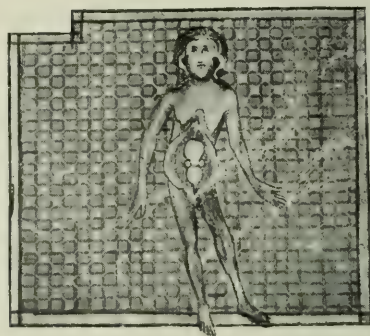
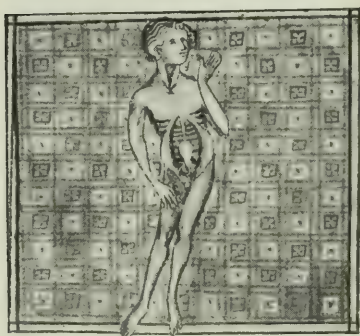


PLATE XXVII. MUNDINUS (?) LECTURING ON ANATOMY



TO ILLUSTRATE THE ANATOMY OF
HENRI DE MONDEVILLE

BODLEIAN MS. ASHMOLE 399 fo. 34 r



PLATE XXVIII. A DISSECTION SCENE
circa 1298

A STUDY IN EARLY RENAISSANCE ANATOMY,

WITH A NEW TEXT :

THE ANOTHOMIA OF HIERONYMO MANFREDI (1490)

BY CHARLES SINGER

TEXT TRANSCRIBED AND TRANSLATED BY A. MILDRED WESTLAND

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I. ANATOMY IN THE FOURTEENTH AND FIFTEENTH CENTURIES

THERE was little or no progress in the knowledge of anatomy between the death of Mondino in 1327 and the sixteenth century. This appears the more remarkable when we recall how widespread was the practice of dissection during the period. In France, at the University of Montpellier, public dissections were decreed in the year 1377,¹ and Catalonian Lerida followed suit in 1391.² At Bologna, where dissection had long been customary, it received official recognition in the University Statutes in 1405,³ and the same event took place at Padua in 1429. Public anatomies were instituted at the University of Prague in 1460, of Paris in 1478, and of Tübingen in 1485.⁴ For these 'Anatomies' the bodies of executed criminals were usually employed, and therefore the number of subjects available varied greatly in different localities.⁵ In addition to

¹ *Cartulaire de l'Université de Montpellier (1180-1518)*, Montpellier, 1894, p. 21.

² Dates of the institution of dissection at this and other Universities are given by F. Baker in *Bulletin of the Johns Hopkins Hospital*, vol. xx, p. 331, Baltimore, 1909.

³ Statuti dell' Università di Medicina e di Arti del 1405, Rubr. lxxxxvi ('De anothomia quolibet anno fienda') in the *Statuti delle Università e dei collegi dello Studio bolognese*, edited by Carlo Malagola, Bologna, 1888, p. 289.

⁴ J. Säxinger, *Ueber die Entwicklung des medizinischen Unterrichts an der Tübinger Hochschule*, Tübingen, 1884, pp. 5 and 10.

⁵ How rarely dissections were conducted in some of the Universities may be gathered from the first statutes of the medical faculty of Tübingen, dated 1497. These ordain a dissection *every three or four years*. Not till 1601 was an anatomy

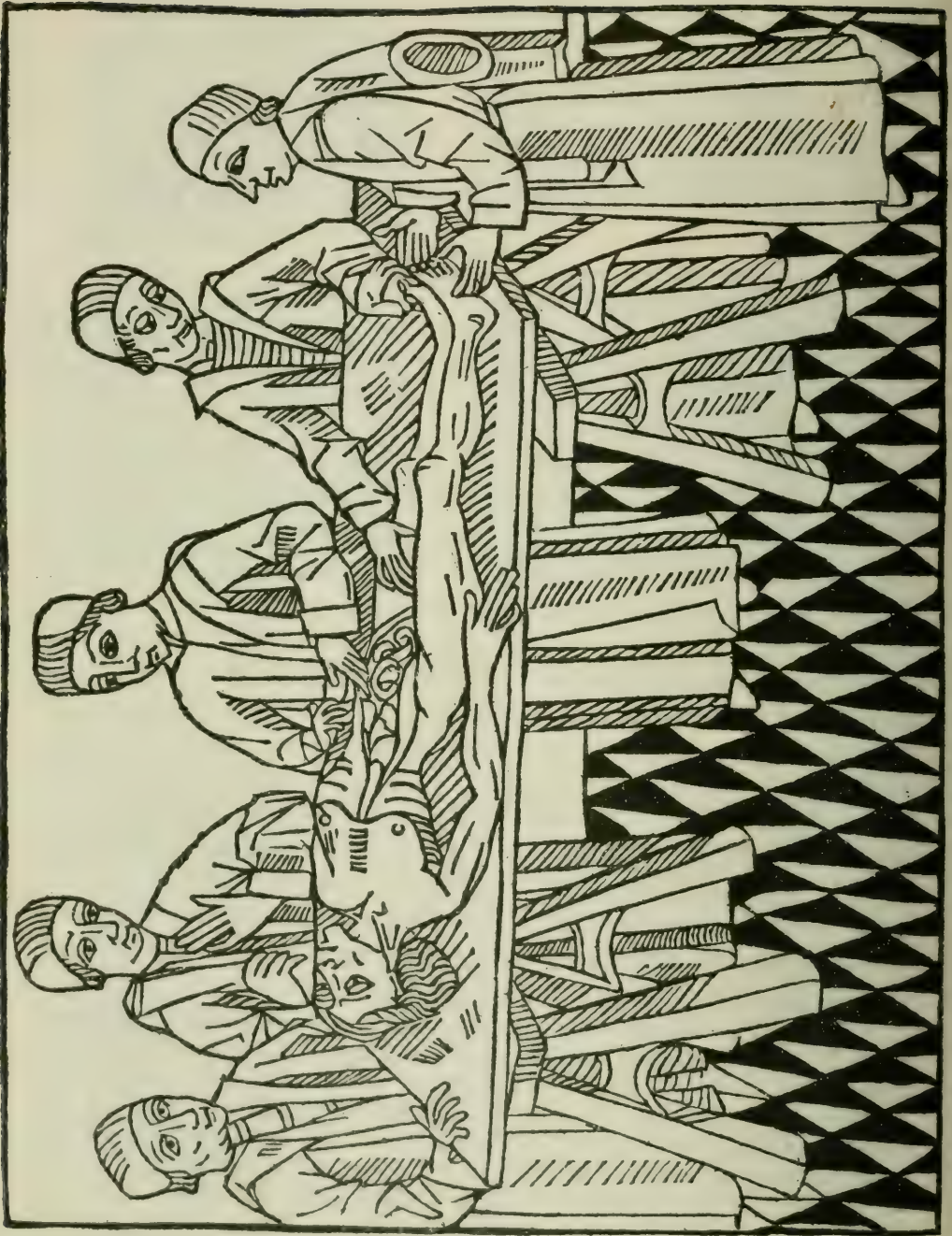


Fig. 1. From the French translation of Bartholomaeus Anglicus, Lyons, 1482. The first printed picture of dissection.



PLATE XXIX. A POST-MORTEM EXAMINATION. Late XIVth Century



PLATE XXX a. A DEMONSTRATION OF

SURFACE MARKINGS

Second half of XVth Century



PLATE XXX b. A DEMONSTRATION OF THE BONES

TO ILLUSTRATE GUY DE CHAULIAC

First half of XVth Century

these regular dissections, there was certainly a considerable amount of post-mortem examination, surreptitious (Plate xxviii *b*¹), or even open (Plate xxix ²), long before Benivieni published his memorable list of cases.³

That so much industry was rewarded by so small an increase in knowledge may probably be attributed to the method adopted.

held at Tübingen even once a year (see Säxinger, loc. cit.). Even at Montpellier in the sixteenth century the scarcity was so great that Rondelet (1507-66) was on one occasion reduced to dissect the body of his son. For this terrible incident see A. Portal, *Histoire de l'Anatomie et Chirurgie*, Paris, 1770, vol. i, p. 522; A. Haller, *Bibliotheca anatomica*, Lib. iv, § clxxxiv, Leyden, 1774, vol. i, p. 205; and A. O. Goelicke, *Introductio in historiam litterariam anatomes*, Frankfurt, 1738, p. 136. There was, however, a relatively plentiful supply of subjects in the Italian Universities and especially at Bologna and Padua in the fourteenth, fifteenth, and sixteenth centuries (cp. A. Haller, *Bibliotheca anatomica*, introduction to Lib. v, p. 218). This was perhaps due to the utterly depraved state of public and private morals to which the peoples of the peninsula had been reduced by the excesses of the tyrants and the condottieri.

¹ Plate xxviii *b* is perhaps the earliest representation of the practice of dissection yet brought to light. It is described in Charles Singer, 'Thirteenth-Century Miniatures illustrating Medical Practice', *Proceedings of the Royal Society of Medicine, Section of the History of Medicine*, 1916, vol. ix, pp. 29-42.

² Plate xxix: a post-mortem scene in the late fourteenth century, from a French MS. of the *Grande Chirurgie* of Guy de Chauliac, Bibliothèque de la Faculté de Médecine de Montpellier, MS. 184 français, folio 14 recto. The scene is laid in the bedroom of the deceased. In the left-hand top corner is the bed, by the side of which a female figure, partly obliterated, is praying. Below and to the left are two other female figures, and a man richly dressed in an ermine-trimmed robe. These are presumably the relatives of the dead. The corpse, that of a woman, has been placed on a bare table and is opened from the larynx to the symphysis pubis. In front stands a lad holding a round wooden vessel for the reception of the viscera, and farther to the right is a stool on which are placed two or three instruments. The physician, in full canonicals, is at the extreme right of the picture. The actual process of examination is being made by three of his assistants. To the left the first of these deepens, with a knife, the incision that has already been made over the sternum, the second is grasping with his two hands and rolling up the great omentum so as to display the viscera beneath, and the third holds a wand in his right hand, with which he points to the abdomen, while in his left he carries a book. Five others throng into the room from a passage which opens into it.

³ Antonio Benivieni, *De abditis nonnullis ac mirandis morborum et sanationum causis*, Florence, 1506. In the description of Case 32, Benivieni expresses surprise at having been refused permission to perform a post-mortem examination, as though it were unusual for him to meet rebuffs of the kind. 'Experimento comprobare volentes, corpus incidere tentavimus sed nescio qua superstitione negantibus cognatis, voti compotes fieri nequivimus.'

The so-called 'anatomies' were conducted in the most formal manner. Bertuccio, for example, who succeeded Mondino as professor of Surgery at Bologna, was accustomed, as we learn from his pupil Guy de Chauliac, to give short systematic anatomical demonstrations on a fixed and rigid method.¹ The occupant of

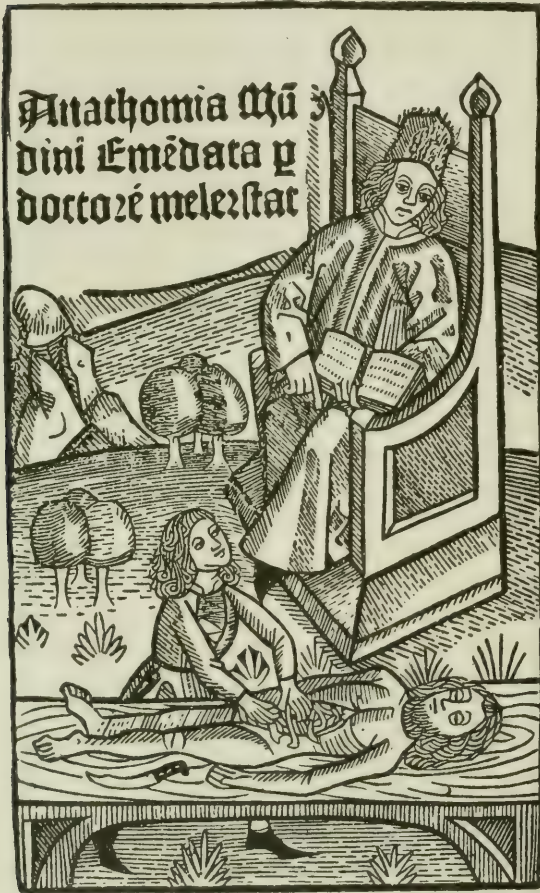


FIG. 2. Title-page of Mellerstadt's edition of the *Anatomy of Mondino*, Leipzig, 1493. The scene is laid in the open air.³

the chair at this period was indeed no professor in the modern sense of the word. To expound the tradition of anatomy as it had reached him was regarded as the limit of his duty. Of any attempt to extend the bounds of knowledge, of any systematic endeavour to correct or improve the anatomical views of his predecessors, we find little or no trace. Indeed, at Padua it was expressly laid down in the statutes that the exposition of anatomy should follow the very words of Mondino.²

Early figures portraying the teaching of anatomy (Plate xxvii and Figs. 1-3, 5) usually show us a medical doctor sitting at a desk, well removed from the subject of dissection, and reading from his text-book the description of the part. Meanwhile an assistant, who is usually also a doctor, performs the actual work of dissection. The professor of

¹ See E. Nicaise, *La Grande Chirurgie de Guy de Chauliac*, p. 30, Paris, 1890.

² 'Ut Anatomici explicationem ipsius Mundini sequantur', Francesco Maria Colle, *Storia scientifico-letteraria dello Studio di Padova*, 4 vols., Padua, 1824-5, vol. iii, p. 108.

³ Martin von Mellerstadt, also called Pollich or Polich.

Surgery, to whom the teaching of anatomy was entrusted, stands by with a pointer to indicate the different organs.

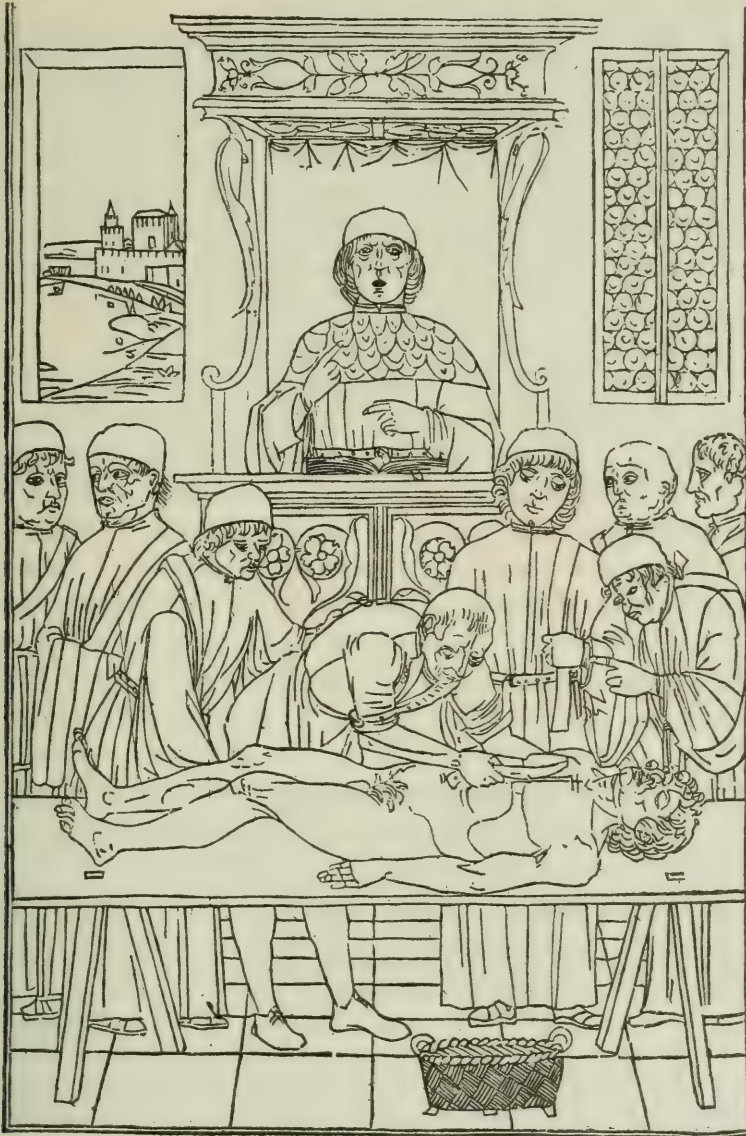


FIG. 3. A DISSECTION SCENE

From the Venice 1495 edition of 'Ketham' (compare Plate xxvii).

Sometimes the professor changes places with the reader at the desk. In some later MSS. the teacher is figured as himself handling the body and demonstrating to his pupil (Plate xxx a¹)

¹ Plate xxx a, from a late fifteenth-century Provençal translation of the *Grande Chirurgie* of Guy de Chauliac. Vatican Library, MS. hispanice 4804, folio

and *b*¹), but there is evidence that the miniatures portraying this are the work of artists unfamiliar with dissection and with the teaching of anatomy.

The study of anatomy had to contend with two great difficulties, want of subjects for dissection, and faith in the written word.

Thus, at Bologna, where it was arranged that every medical student of over two years' standing should attend an *Anatomy* once a year, no less than twenty students were admitted to see the anatomy of each man, and thirty to the anatomy of each woman.² This was all the practical instruction received. Some other Universities had to be content with the cadaver of a single criminal per annum for the whole body of students.

In the *first* period during which the human body was dissected in Europe, the thirteenth century, a certain amount of progress was certainly made, despite the rarity of subjects. The rebirth of learning in the thirteenth century was not, however, as favourable to anatomical progress as might have been hoped. Galen, indeed, ceased to be a mere name, and the Latin translations of his text, or of its adumbra in the writings of the Arabians, became ever more familiar. On the other hand, with more authoritative texts in their hands, men were but the more inclined to follow the evil scholastic way, and to trust rather to the written words of the master than to the evidence of their own senses. Thus it came about that the *second* period, which covers the fourteenth and most of the fifteenth century, was really stationary so far as the first-hand knowledge of anatomy was concerned. With the last decade of the fifteenth century, however, there opens a new and

8 recto. A professor and pupil are examining a wasted corpse placed on a trestle in the open air. The teacher is pointing out the surface markings.

¹ Plate xxx *b*, from the French Guy de Chauliac MS. in the Bristol Reference Library, folio 25 recto. The MS. dates from between the years 1420 and 1435; cp. Norris Mathews, *Early Printed Books and MSS. in the Bristol Reference Library*, Bristol, 1899, p. 70; J. A. Nixon, 'A New Guy de Chauliac MS.', in *Transactions of the XVIIIth Internat. Cong. of Med., Sect. of Hist. of Med.*, London, 1914, p. 419; and Charles Singer, 'The Figures of the Bristol Guy de Chauliac MS. circa 1430', *Proceedings of the Royal Society of Medicine, Section of the History of Medicine*, 1917, vol. x, pp. 71-91. The figure shows a professor and pupil. The former is demonstrating the bones of a skeleton.

² The number of female criminals being less than the number of male criminals, Ludovico Frati states (*La vita privata di Bologna dal secolo XIII al XVII*, Bologna, 1900, pp. 116-18) that only two anatomies *in all* were held each year, and thirty students admitted to the female and twenty to the male dissection. This would mean far less than *two dissections a year for each student* of over two years' standing.

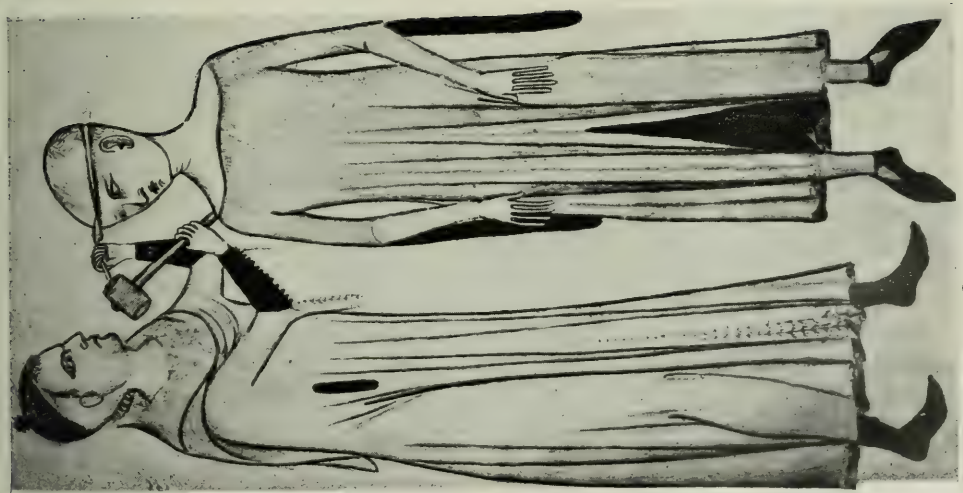
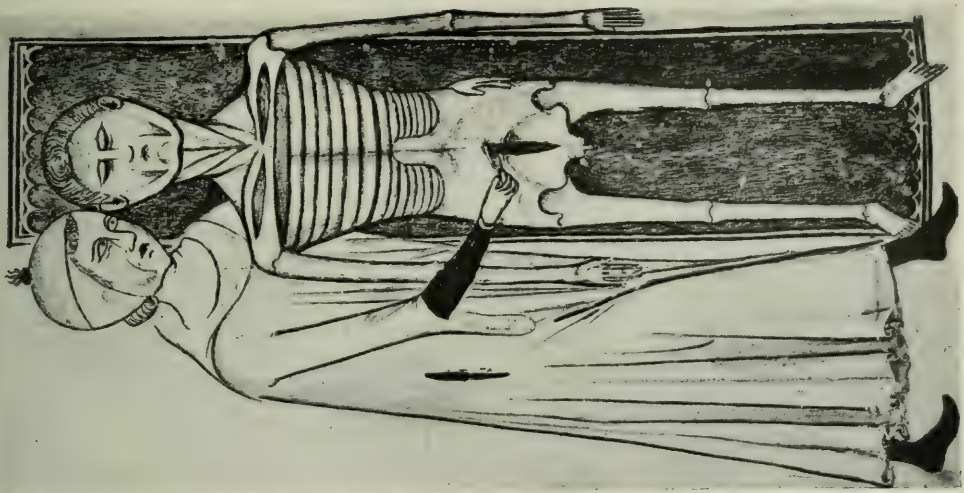


PLATE XXXI. From the MS. of GUY DE VIGEVANO of 1345 at CHANTILLY

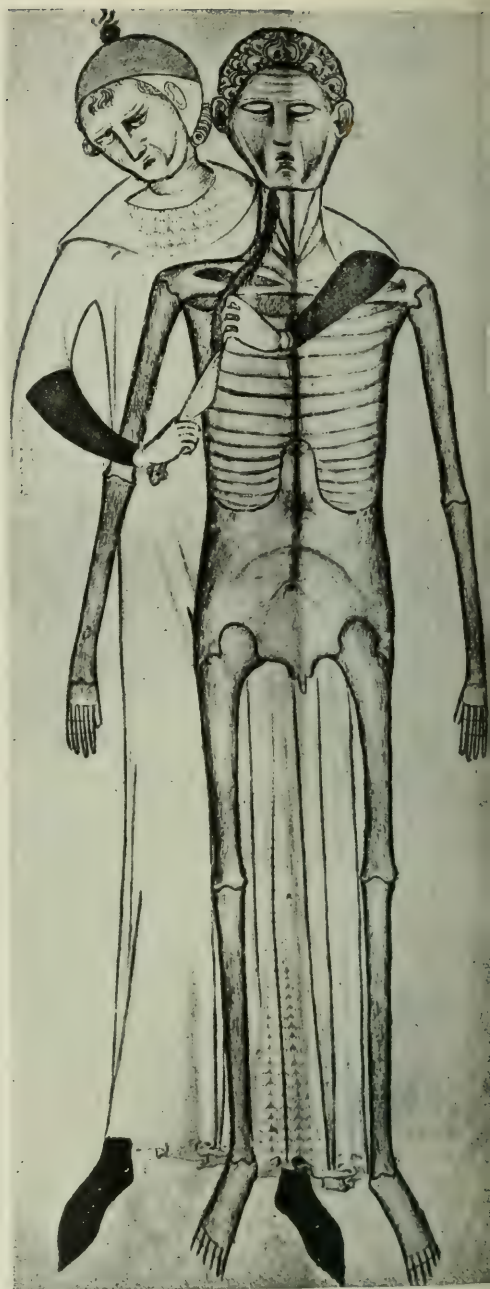
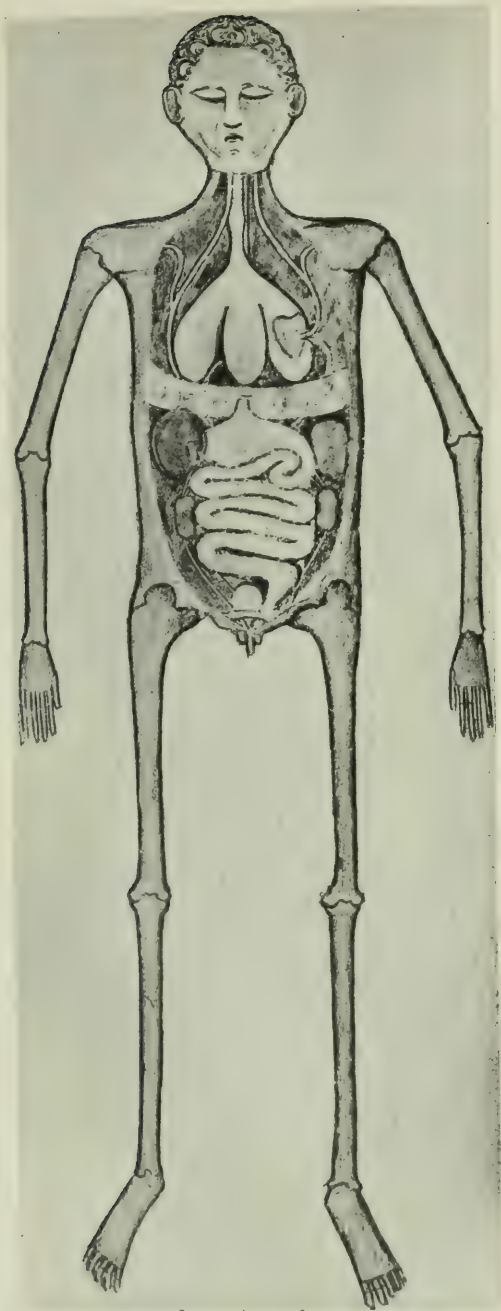


PLATE XXXII. From the MS. of GUY DE VIGEVANO of 1345
at CHANTILLY



FIG. 4. From the English translation of Bartholomaeus Anglicus, printed by Wynkyn de Worde, 1495. The first picture of dissection in an English-printed book.



VENETIIS ANNO .D. M.CCCC.XXXV.

FIG. 5. A LECTURE ON ANATOMY

From the 1535 Venice edition of Berengar of Carpi's Commentary on Mondino.

third period in the history of our subject. From that time dates the true era of anatomical renaissance, which may be regarded as continuing until the commencement of modern anatomy with the great work of Vesalius in 1543.

We have said that throughout the second period, the formal demonstrations based on the declaimed text of Galen or Avicenna or Mondino were practically the sole opportunities afforded to either teacher or pupil for the investigation of the minuter details of the human frame. But in making this statement concerning the arrest of anatomical progress, we must expressly exclude the products of the mighty genius of Leonardo da Vinci (1452–1519), whose anatomical researches were without influence, and remained long unnoticed.¹ We must also omit evidence gathered from the work of such early Renaissance painters as Antonio Pollaiuolo (1429–98) or Andrea del Verrocchio (1435–88), for these pursued the study of anatomy in a special field and with a special object.² Furthermore, there are a number of artists of similar date of whose anatomical studies we have no direct evidence, but who yet outlined the muscles of the nude human figure in such a way as leads us to suppose that they had investigated the superficial structures at least of flayed parts. Such is the suggestion of some of the work of Luca Signorelli (*c.* 1442–*c.* 1524), and of Andrea Mantegna (died 1506). With such reservations, however, it is probably true that no evidence is forthcoming until the last decade of the fifteenth century of any advance from the standpoint of Mondino.³

But if descriptive anatomy developed slowly in the hands

¹ The anatomical works of Leonardo have now been rendered accessible in *Tredici Foglie della Royal Library di Windsor. Leonardo da Vinci, Quaderni d'anatomia . . . Pubblicati da O. C. L. Vangensten, A. Fonahm, H. Hopstock, Christiania, 1911, &c.*

² Pollaiuolo and Verrocchio only studied surface anatomy, so far as is known. For a summary of the anatomical work of these painters see M. Duval and E. Cuyer, *Histoire de l'Anatomie plastique*, p. 20, Paris, 1898.

³ It has been suggested that Giammatteo Ferrari da Grado (Matthaeus de Gradibus), who was professor of Medicine at Pavia 1432–72, made original contributions to anatomy. He wrote no separate work on anatomy, but his observations on the ovaries (which he was perhaps the first to call by that name) appear in his *Practica*, Milan, 1471, and in his *Expositiones super vigesimam secundam Fen tertii canonis Avicennae*, Milan, 1494. An interesting account of Ferrari's life and work is given by his descendant, H. M. Ferrari, in *Une Chaire de Médecine au XV^e siècle; Un professeur à l'université de Pavie de 1432 à 1472*, Paris, 1899. In this work the claim that De Gradibus was an original and independent observer is effectively disposed of.

of the physicians, the art of graphic representation of anatomical structures was still more backward. Several groups of anatomical drawings of mediaeval date have come down to our time, but examination of them shows that they have been drawn without direct reference to the human frame. Some of these figures are of the crude type known as the 'five-figure series' (Plate xxxiii), mere traditional diagrammatic sketches.¹ Hardly better or more instructive are the series of dissections which illustrate certain MS. works of Henri de Mondeville (Plate xxviii a)² and Guido de Vigevano (Plates xxxi and xxxii), 1345.³ A few sketches representing the separate organs have also survived (Fig. 6),⁴ but these never suggest that the draughtsman had before him the structure which he seeks to depict, and the drawings appear to have been made in order to illustrate contemporary physiological theory rather than observed anatomical fact. Even the magnificent illuminated Dresden Codex of Galen, prepared in France or Flanders as late as the second half of the fifteenth century, betrays not the slightest first-hand knowledge of anatomy.⁵ Although the

¹ At least six Western copies of this series, besides three or more of oriental origin, have now been detected. The Western MSS. and their dates are as follows :

- (a) Munich, Hof- und Staatsbibliothek, Cod. lat. monacensis 13002, before 1158.
- (b) Munich, Hof- und Staatsbibliothek, Cod. lat. monacensis 17403, circa 1250.
- (c) Bodleian Library, MS. Ashmole 399, circa 1290.
- (d) Dresden, Kgl. Öffentl. Bibliothek, Codex 310, before 1323.
- (e) Bodleian Library, MS. e Museo 19, before 1344.
- (f) Library of Count F. Zdenho von Lobkowitz in Raudnitz, of 1399.

See E. Seidel and K. Sudhoff, especially 'Drei weitere anatomische Fünfbilderserien aus Abendland und Morgenland', in *Archiv für Gesch. der Med.*, iii, p. 165, Leipzig, 1910.

² Cp. K. Sudhoff in *Ein Beitrag zur Gesch. der Anatomie im Mittelalter*, Leipzig, 1908.

³ E. Wickersheimer, 'L'Anatomie de Guido de Vigevano, médecin de la reine Jeanne de Bourgogne (1345)', in *Archiv für Geschichte der Med.*, vii, 1, Leipzig, 1914. M. Wickersheimer has kindly given permission for the reproduction of the figures in Plates xxxi and xxxii.

⁴ Notably the MS. Roncioni 99, dating from the first half of the twelfth century, in the University Library of Pisa, reproduced by K. Sudhoff in the *Archiv für Gesch. der Med.*, vii, Tafel xiv, 1914. Also separate organs are depicted in the Bodleian MS. Ashmole 399, dating from the end of the thirteenth century, reproduced in Fig. 6.

⁵ The miniatures of the Dresden Codex have been studied by L. Choulant, *Geschichte und Bibliographie der anatomischen Abbildung nach ihrer Beziehung auf anatomische Wissenschaft und bildende Kunst*, Leipzig, 1852, and in the *Archiv*

illustrations of this MS. are prepared with the utmost technical skill, they yet show us a teacher exhibiting to his pupils a heart of the form found on playing-cards, and other anatomical figures scarcely more faithful to the facts (Plate xxxiv).

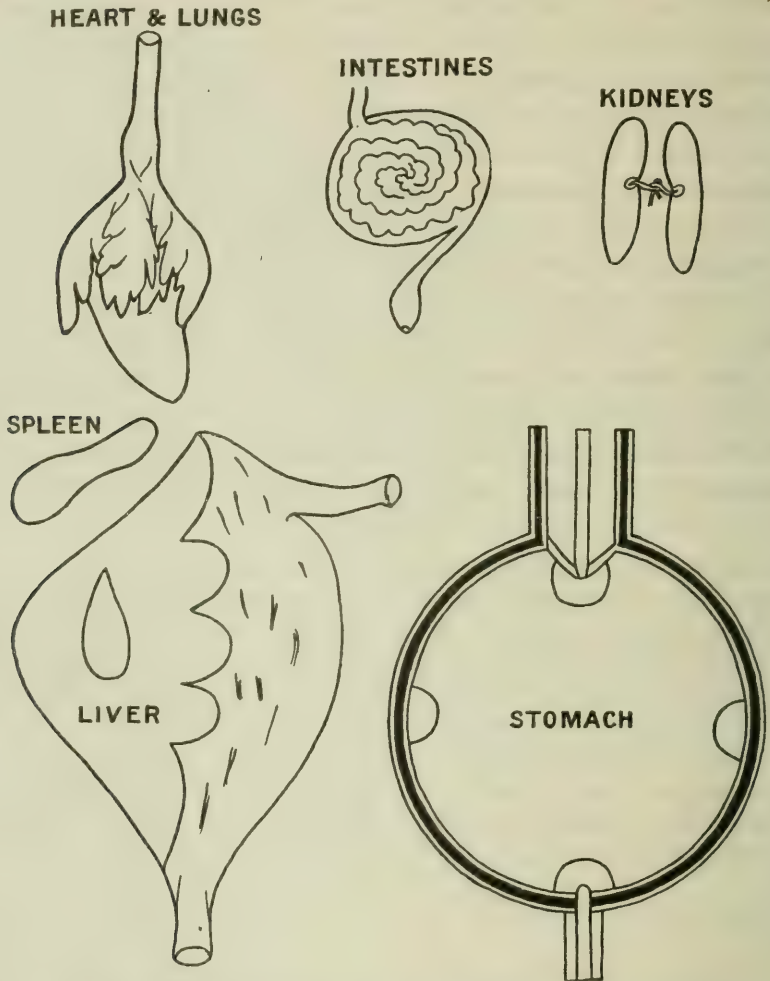


FIG. 6. DIAGRAMS OF THE INTERNAL ORGANS

After Bodleian Library MS. Ashmole 399 of about 1298, fos. 23 recto-24 recto.

The spirit of investigation of the artist who perforce went direct to nature, dissecting with his own hands and observing *für die zeichnenden Künste*, II. Jahrgang, Leipzig, 1856, p. 264. More recently the MS. has been most carefully described and its miniatures reproduced by E. C. van Leersum and W. Martin, *Miniaturen der lateinischen Galenos-Handschrift der kgl. öffentl. Bibliothek in Dresden, in phototypischer Reproduktion*, Leyden, 1910. We have to thank Dr. Van Leersum of Leyden for kind permission to reproduce the figures of Plate xxxiv.

with his own eyes (Plate xxxvi), showed itself indeed far more fruitful than the tedious *ex cathedra* methodization of the professor.¹ Yet the system of the schools needed to be combined with the freedom of the artist for the production of an effective anatomical work. What the projected treatise of Marcantonio della Torre (1473–1506) might have been we may guess from the anatomical sketches of Leonardo da Vinci (Plate xxxv), who was to have been associated with him in the work.² In the event, however, the medical schools had to wait yet another generation before the subject was placed on a sound basis by André Vesale.

The Mondino pamphlet—for it is little more—used since its author's death in 1327 as a text-book in the schools of northern Italy, was first printed in 1478. Not until the last decade of the fifteenth century did there appear another work bearing evidence of the hand of a practical anatomist. This was an Italian translation of Ketham's *Fasciculus medicinae*, impressed at Venice in the year 1493.³ The volume comprises Mondino's pamphlet and a collection of other medical tracts that were probably put together by Giorgio di Monteferrato from the work of a writer of the previous century, for their contents are traceable to a fourteenth-century MS.⁴ The text is neither original nor remarkable, but the Venice volume derives its importance from certain figures which appear in it for the first time.

Two of these plates are of great interest both intrinsically and also in relation to the history of anatomy. One of them is the magnificent representation of a dissection scene, which is regarded as perhaps the finest example of book illustration produced during the first century of typography⁵ (Plate xxvii). This work of the

¹ Cp. P. Triaire, *Les leçons d'anatomie et les peintres hollandais aux XVI^e et XVII^e siècles*, Paris, 1887.

² For della Torre and his projected work on anatomy, see G. Cervetto, *Di alcuni illustri anatomici italiani del decimoquinto secolo*, p. 46, Verona, 1842; also L. Choulant, *Geschichte der anatomischen Abbildung*, p. 5, Leipzig, 1852.

³ The first edition appeared in Venice in 1491 and is in Latin. It is of less typographical interest.

⁴ K. Sudhoff, 'Eine Pariser "Ketham" Handschrift aus der Zeit König Karls VI (1380–1422)', in *Archiv für Geschichte der Medizin*, vol. ii, p. 84, Leipzig, 1909; 'Neue Beiträge zur Vorgeschichte des Ketham', in *Archiv für Geschichte der Medizin*, vol. v, p. 280, Leipzig, 1912.

⁵ Prince d'Essling, *Les livres à figures vénitiens de la fin du XV^e siècle et du commencement du XVI^e*, part i, vol. ii, p. 56, Florence and Paris, 1908.

'maître aux dauphins', as the unknown artist is called by critics,¹ is doubly interesting, for it is the subject of an experiment in colour printing, no less than four pigments being laid on by means of stencils. As early as 1457 the method of stencilling was employed for colouring the initials of a Psalter, and in 1485 Erhard Ratdolt in an astronomical work added yellow to the earlier red and black. The figure from which our plate is taken represents, however, the first attempt at a complex colour scheme and leads up to the work of Hugo da Carpi.²

In this picture the professor, a youthful figure perhaps intended to represent Mondino himself, is shown standing at a desk which hides his book. Around a corpse, laid on a trestle table before him, there cluster a number of men in doctor's robes. Their valid faces are sufficient to convince us that the artist is here presenting us with portraits. One of the listeners has removed his robe and stands with upturned sleeves and knife in hand, ready to make the first incision on the direction of the doctor, who points to the part with a wand held in the left hand. In the impression of 1495 and in those of later date, the book appears above the desk, the attitudes of the students are somewhat changed, and many other details are altered. In all these, however, the blocks have been recut and the result is artistically inferior³ (Fig. 3).

The second plate from the 1493 Ketham with which we are here concerned is the outline of a female body, in a traditional pose,⁴ laid open to exhibit some of the internal organs (Fig. 7). These had clearly been sketched from the object, and therefore this drawing, the first printed figure of its kind, may be said to introduce the new era for the investigation of the human frame. The anatomical renaissance had begun. Into a discussion of the full development of that age we cannot now enter. But the MS. of Manfredi, with which we have here to deal, was written at the very dawn of the new era and is itself one of its earliest documents.

¹ Eugène Piot, *Le Cabinet de l'amateur*, nouv. série, Paris, 1861, 'Le maître aux dauphins', p. 354 et seq. The dolphins are seen on either side of the chair in Plate XXVII.

² Duc de Rivoli, *Bibliographie des livres à figures vénétiens*, p. 110, Paris, 1893.

³ Cp. G. Albertotti, *Nuove osservazioni sul 'Fasciculus medicinae' del Ketham*, Padua, 1910.

⁴ See K. Sudhoff, 'Weibliche Situsbilder von ca. 1400-1543', in *Tradition und Naturbeobachtung*, p. 79, Leipzig, 1907. The number and character of the indication lines attached to this figure suggest that the block from which the impression has been taken had previously been used for some other publication. This work, however, if it exists, has not yet come to light.

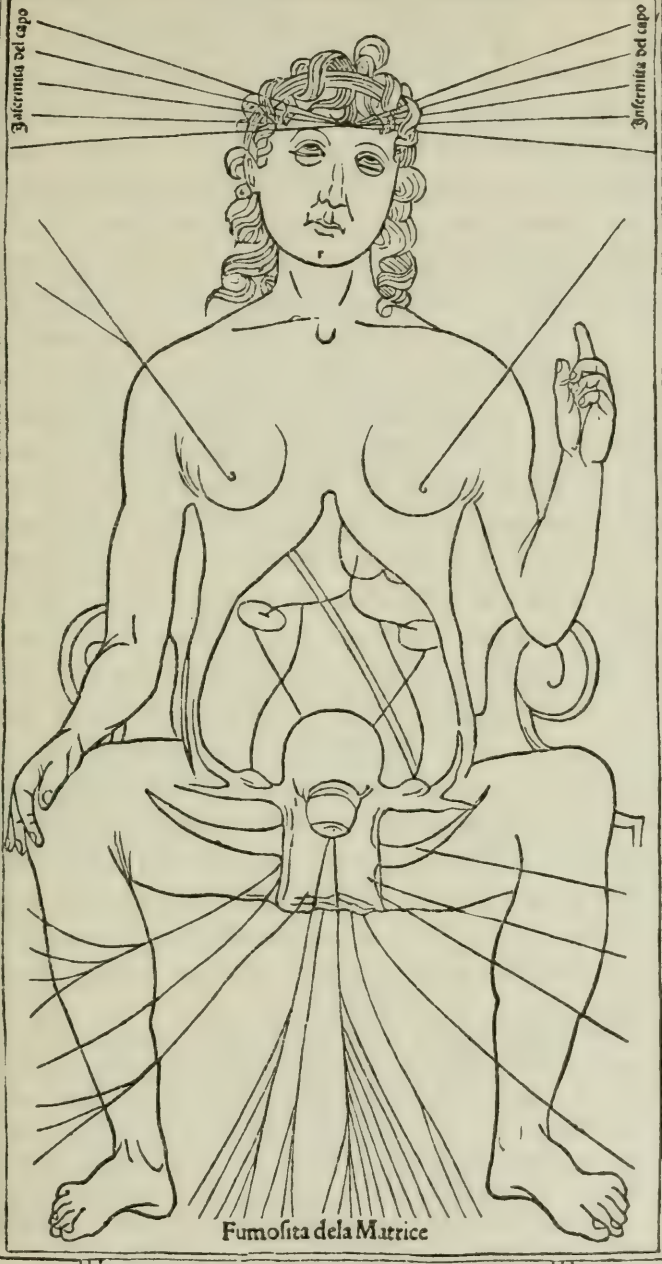
Figura dela matrice dal natural. d'ua Dona

Straga rige obliqione
C'p'galka. i. d'oloi di reña
e a' b'umio di cap'g'li
Z'at'g'biar'g'ia ruoto ud
f'om'ne d'ri'co
Ogn' r'ate de ambulante
e di uent'ofita la quale
f'ra'co'ise de lu'ge ni logo

Inflation di poppe

Za f'ecund'ia e vna cer
te pelle nela quale giace
el pu'ro nela matrice.

Inertia: f'ecita homo le
p'ia m'ou'p'ca par'co'io de
f'ecida r'ag'io'ne ou' r' e cad'i
da f'redo co'f'ra'no de po'ra.



Malconca
f'ec'ia
f'ec'io'ne
f'ec'io'ne nel fronte
ba'ulti e de d'ri'co.
Emp'io'ca i'oc f'p'ro d'ra
g'ue
Emp'io'ca i'oc ap'of'ima tu
r'ic'io'ne
p'ic'ur' e f' p'ella
f'lu'go di cat'ar'ro
f'lu'go d'oc'io'

Inflation di poppe

S'g'uita o'f'f'arie inci
nd'i i'nf'ra'f'nc'io' c'ic'ulo
la co'cept'io'ne: qu'o mul'iere
bono p'or'are uol'ent'e
uol'g'io'ne co'cep'e fe ber'e
na co'e uol' co'cept'io'ne de
ben' g'uar'd'are co'e f'er'uda
ce no' f'ia troppo b'um'io'ne
ne troppo f'ec'ida ne tro-
ppo cal'da ne troppo f'rig'ida
f'er'uda lo o'f'f'io'ne del'i
m'ul't'ru' dela p'eg'na'io'ne
ne ab'und'ante de uari h'u-
m'oi: o uero bian'chi ma
f'angu'gu'ne f'uperf'ui ne
uol'g'io'ne: f'ia la d'ona d'e f'ac'it'e
d'ig'ef'io'ne e f'ia co'f'ru'ua
to el co'p'o i' t'emp'ar'ame't'o

Inertia: f'ecita homo le
p'ia m'ou'p'ca par'co'io de
r'ag'io'ne f'ecida ou' r' e cad'i
da f'redo co'f'ra'no de po'ra.

Inertia f'ecita homo le
p'ia m'ou'p'ca par'co'io de
r'ag'io'ne f'ecida ou' r' e cad'i
da f'redo co'f'ra'no de po'ra.

Fumofita dela Matrice

Sono alcune cose da notare e alcuni segni de la co'cept'io'ne dela donna et p'ri-
mo f'egno e quello che se cog'no'ce per la co'iu'nc'io'ne de lo h'omo e de la dona.
Imper'io' che se la donna d'op'po el co'cept'io'ne f'ec'ia f'redo o d'oloi de reni
e f'egno de co'cept'io'ne: Et se el co'lo' dela f'ac'ia fu'or' del' u'f'ro e u'ene ad' m'ara
re e f'egno de co'cept'io'ne. Et se d'ad'ra algun' ab'uf'it'ato con'e terra o carbo-
na e f'egno de co'cept'io'ne. Et se u' uol'ia f'ap'ere fe e m'af'chio o f'er'm'ina quello
che co'cept'io'ne: f'el co'lo' del' u'f'ro e r'of'fa e el u'entre se g'ien'f'ia de la parte de
f'ra u' f'er'm'ina r'ot'onda e el l'acte e'f'ic' delle poppe f'p'ef'fo: ben' co'cto e dig'ef'it'ato
e fe p'one'nd'o f'op'ra una cof'a p'ul'ira non fe dif'par'ite ma f'ara i'nf'eme allo-
ra f'ara m'af'chio.

Fig. 7. A FEMALE FIGURE LAID OPEN TO SHOW THE WOMB AND OTHER ORGANS
From the 1493 Venice edition of 'Ketham' translated into Italian. This is the first
printed anatomical figure drawn from the object.

II. BOLOGNESE WORKS ON ANATOMY

An organized Medical Faculty existed at Bologna at least as early as 1156,¹ though the first record of dissection there is of considerably later date. In February 1302 a certain Azzolino died under suspicious circumstances. Poison was suspected, an inquest was held and a post-mortem examination ordered. The investigation was conducted by two physicians and three surgeons, who unanimously agreed 'that the said Azzolino assuredly met his death by no poison, but on the contrary, we assert that the quantity of blood collected in the great vein known as the *vena chilis* [vena cava]² and in the veins of the liver adjacent thereunto, has prevented the due movement of the *spiritus* throughout the body, and has thus produced the diminution or rather extinction of the innate heat and thereby induced a rapid post-mortem discoloration. Of this condition we have assured ourselves *by the evidence of our own senses and by the anatomization of the parts.*'³

The first anatomical document emanating from the University of Bologna is, however, of still earlier date, and is the work of William of Saliceto (1210 ?-80). This writer was educated at Bologna, and it is claimed that he was the first to dissect the human body there.⁴ His *Cirurgia*, which was completed in 1275 (*editio princeps*, Piacenza, 1476), is divided into five books, of which the fourth and shortest is devoted to anatomy. Its descriptions are brief and concise. They are often clearly the result of actual observation, and they show hardly any trace of the absurd and irritating teleology that the influence of the Arabians and

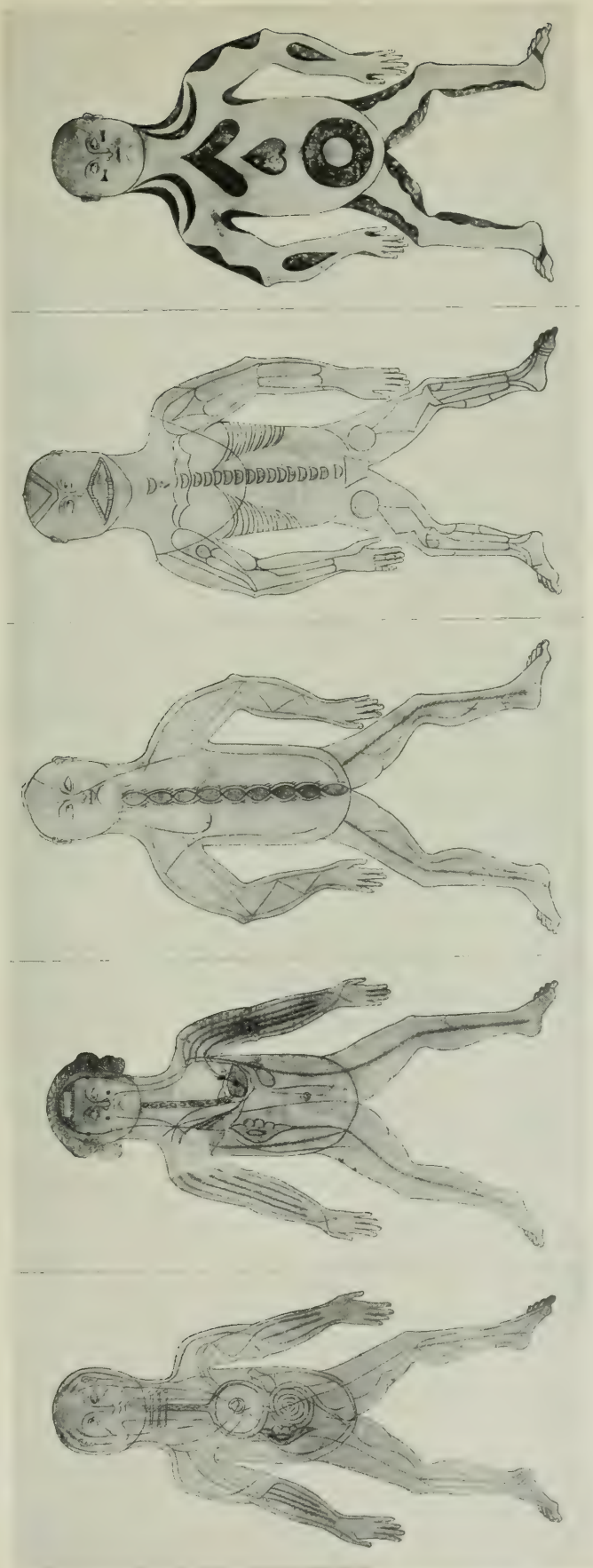
¹ Michele Medici, *Della vita e degli scritti degli anatomici e medici fioriti in Bologna dal comincio del secolo XIII*, Bologna, 1853; *Compendio storico della scuola anatomica di Bologna dal Rinascimento delle Scienze e delle Lettere a tutto il Secolo XVIII*, Bologna, 1857.

² The mediaeval term, 'vena chilis', lasted in anatomy until the end of the sixteenth century and probably later. 'Chilis' is a corruption of the Greek *κοιλη*. This hybrid name was abandoned by Vesalius (*Fabrica*, 1543 Basle edition, p. 376) in favour of the title 'vena cava'.

³ The passage is translated from Michele Medici, *Compendio storico*, pp. 10-11.

⁴ See A. Laboulbène, 'Les anatomistes anciens', in *Revue scientifique pour la France et pour l'Étranger*, vol. xxxviii, p. 641, Paris, 1886; Robert Ritter von Töply in Puschmann, Pagel, and Neuburger, *Handbuch der Geschichte der Medizin*, vol. ii, p. 197, Jena, 1903; G. Martinotti, 'L'insegnamento dell' Anatomia in Bologna prima del secolo XIX', in *Studi e Memorie per la storia dell' università di Bologna*, vol. ii, p. 51, Bologna, 1911.

PLATE XXXIII. The FIVE-FIGURE SERIES BODLEIAN MS. ASHMOLE 399, about 1292 Fos. 18r-22r



VEINS, &c.

ARTERIES

NERVES

BONES

MUSCLES

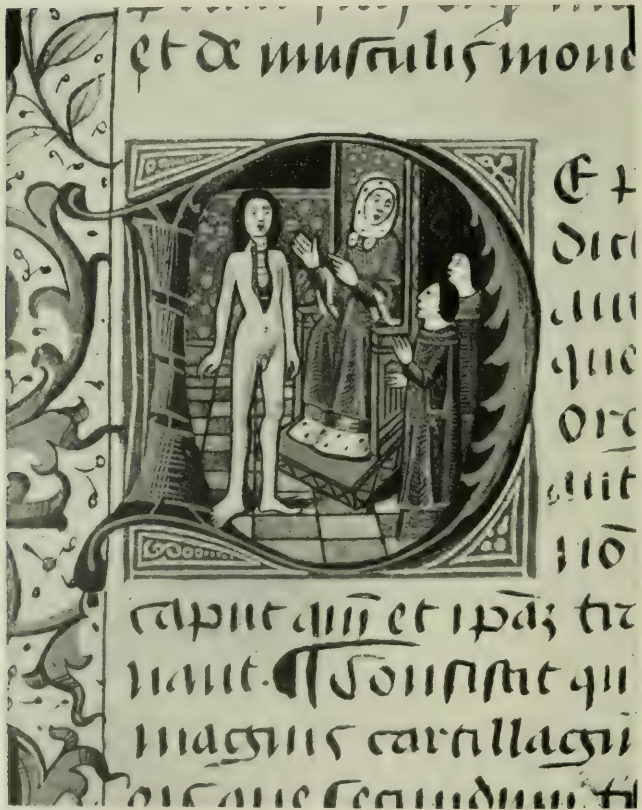


PLATE XXXIV. DEMONSTRATIONS OF ANATOMY

Second half of XVth Century

of Galen made customary in early anatomical literature. The anatomy of Saliceto appears to us very sensible and so far as it goes practical. It betrays the method rather of the Salernitan than of the Arabian anatomical writings, and is on the whole the best European work of the kind before the Renaissance. It was, however, soon replaced by the text-book of Mondino di Luzzi (1285–1327),¹ which, though inferior to that of Saliceto, held the field until the subject was revolutionized by Vesalius.

Mondino was professor at Bologna till his death in 1327. His work, easily accessible in one of its many editions, 'is corrupted by the barbarous leaven of the Arabian schools, and his Latin defaced by the exotic nomenclature of Avicenna and Rhazes'.² But it is not the language alone that has suffered. The schoolman's attitude, well fitted for the classification of ideas, is an ill instrument for the investigation of Nature, and in the scholastic Mondino the very basis of scientific judgement is undermined, so that he readily accepts the views of the ancients against what must often have been the evidence of his own senses. The work, however useful to the contemporary student, was thus essentially reactionary as against the efforts of the earlier Salernitan anatomists and of William of Saliceto. This is the more remarkable because it is quite clear that he was accustomed to demonstrate on the actual body—a privilege denied to the early Salernitan school,—and he was, moreover, a popular and successful teacher. His work is a manual of dissection rather than a treatise on anatomy. This, added to its conciseness and brevity, strengthened its appeal to the 'practical' man—an epithet claimed then, as now, by the majority of stupid and unpractical people. The personal influence and enthusiasm of its author no doubt helped also towards the phenomenal success of this work, which for two hundred years held a position without rival as the text-book of the medical schools of Italy, where even as late as the sixteenth century Mondino 'was still worshipped by all the students as a very god'.³

¹ An intermediate anatomist was Gulielmo Varignana, who was professor of Medicine in Bologna, and is recorded as having opened for judicial purposes, on February 15, 1302, the corpse of one alleged to have been poisoned. See Michele Medici, *op. cit.* The investigation is referred to above.

² Dr. Craigie in his excellent account of the History of Anatomy, in the ninth and subsequent editions of the *Encyclopaedia Britannica*.

³ 'Mundinus quem omnis studentium universitas colit ut deum', J. Adelphus in his edition of Mondino, Strassburg, 1513.

Mondino was succeeded in the chair of Surgery at Bologna by his pupil, the Lombard Bertuccio, who died in the Black Death of 1347. Bertuccio's surviving work is unnoteworthy, but he was the anatomical teacher of Guy de Chauliac, whose *Surgery*¹ is of great value and was very influential in standardizing practice, especially in the north and west of Europe. Nevertheless it appears to us that the anatomical section is the weakest part of Guy's great work. The teleology that is a blot in Mondino has here become a perfect plague, and Guy's anatomy consists of one-third description and two-thirds wearisomely reiterated reasons for the existence of imperfectly described structures. Through Guy de Chauliac the anatomical tradition of Mondino passed over into the University of Montpellier.

A later fourteenth-century Bolognese writer was Tommaso di Garbo (died 1370), who did little but comment on Avicenna. A surgeon of the next generation, however, Pietro d'Argellata, deserves to be remembered for his description of the examination of the body of Pope Alexander V, who died suddenly at Bologna on May 4, 1410. His account throws light on the customary procedure and may be rendered here.²

'I ordered the attendants', he says, 'first to cut the abdomen from the *pomegranate* [i. e. the Adam's apple or laryngeal cartilage³] to the os pectinis [i. e. the symphysis pubis]. Then, so that they should not rupture the intestines, I myself sought the rectum and ligatured it in two places and then cut it between. Next I removed all the intestines as far as the duodenum and dealt with them as with the rectum, and so I had the intestines clean and without fetor. After this I extracted the liver, seizing its ligaments; then the spleen and then the kidneys, and these were all placed together in a jar. I now passed to the spiritual members [i. e. the thorax] and removed lung and heart and all their ligaments. Then I ligatured the *meri* [the Arabian term for oesophagus] and removed the stomach. When this had been done there were some who wished to remove the tongue but knew not how. I however cut under the chin and extracted the tongue

¹ *Editio princeps*, Lyons, 1478.

² Pietro de Argellata, *Cirurgia*, 'Incipit liber primus chirurgie magistri Petri de la Cerlata' (!), Venice, 1492. Quotation from lib. v, tract. 12, chap. 3. An earlier edition which we have not seen was printed in Venice in 1480.

³ The 'pomegranate' sometimes also means the xiphisternum. It is not clear which is implied here.

through that hole, together with *trachea arteria* [trachea] and *meri*. Then I passed to the *arteria adorti* [aorta] and *vena chilis* [vena cava]. Lastly I removed the ligatured remnant of the intestines as far as the anal margin.'

Giovanni da Concoreggio (died 1438), who was lector in Surgery at Bologna in the early part of the fifteenth century, left a few anatomical observations of little note,¹ and not very much more can be said for his successors and Manfredi's contemporaries Gabriele Gerbi (de Zerbis, died 1505) and Alessandro Achillini (1463–1512). Gerbi² does little but repeat in the most verbose fashion the work of Mondino and of Avicenna, some of whose errors, however—e. g. the three ventricles of the heart—he omits. He wrote also an anatomy of the infant, or rather of the foetus,³ and a treatise taken mainly from Avicenna's *De generatione embryonis*. Like all his work, these are in the full scholastic style of a professor of Logic, a position to which, in fact, he ultimately attained.

Achillini's work⁴ is but a slight advance on that of Gerbi. It is really little else than a note-book for students, and gives the baldest directions for dissection, accompanied by a few comments taken from Avicenna. Achillini occasionally ventures to criticize Mondino, and his work has at least the advantage of brevity. He has a claim to be remembered in that he was the first to describe the duct of Wharton and is said to have been the first to describe the ear ossicles, malleus and incus. Achillini, like Gerbi, was a windy and very 'scholastic' disputator. He was best known to his contemporaries as a supporter of the philosophy of Averroes. In 1506, when driven from Bologna with the other supporters of Bentivoglio, he became professor of Philosophy at Padua.

With Giacomo Berengario da Carpi we come at length to one who definitely advanced the science, and who may be regarded as the first modern anatomist, so far as printed works are concerned. He was professor of Surgery from 1502 to 1527, and during

¹ Giovanni da Concoreggio, *Lucidarium et Flos Medicinæ*, Giunta, Florence, 1521. It contains a few scattered anatomical points.

² De Zerbis, *Liber Anatomie corporis humani et singulorum membrorum illius*, Venice, 1502.

³ Reprinted in the *Anatomia* of Johannes Dryander, Marburg, 1537.

⁴ Alessandro Achillini, *Annotationes anatomie*, Bologna, 1520. This work is also included in the 1502 edition of De Zerbis' *Liber Anatomie*.

that period published his great anatomical work.¹ This volume, though modestly put forward as a commentary on Mondino, is in reality an original contribution of great value. It is the earliest anatomical treatise that can properly be described as having figures illustrating the text (Fig. 8).² Carpi does not hesitate to criticize the work on which he comments—as for instance when he denies

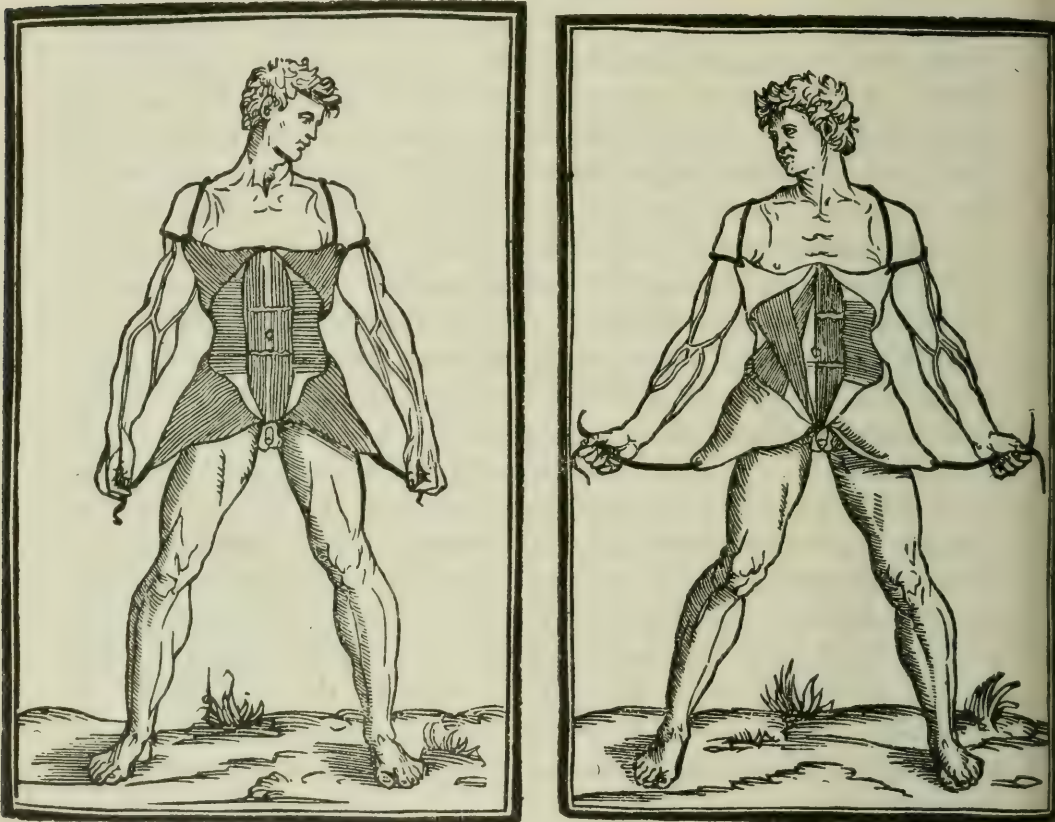


FIG. 8. THE ABDOMINAL MUSCLES

From Berengar of Carpi's Commentary on Mondino, Bologna, 1521.

the existence of the 'rete mirabile' below the brain, though descriptions of the 'rete mirabile' had been based on the statement

¹ *Carpi commentaria cum amplissimis additionibus super anatomia mundini una cum textu eiusdem in pristinum et verum nitorem redacto*, Bologna, 1521. An earlier and less important edition of Carpi was the *Anathomia Mundini noviter impressa ac per Carpum castigata* that appeared at Bologna in 1514.

² The figures in Ketham and in the wretched productions of Johannes Adolphus (J. A. Muelich), of Hundt, and of Peyligk can hardly be said to illustrate the text of anatomical treatises.

From a drawing in the Library, WINDSOR CASTLE

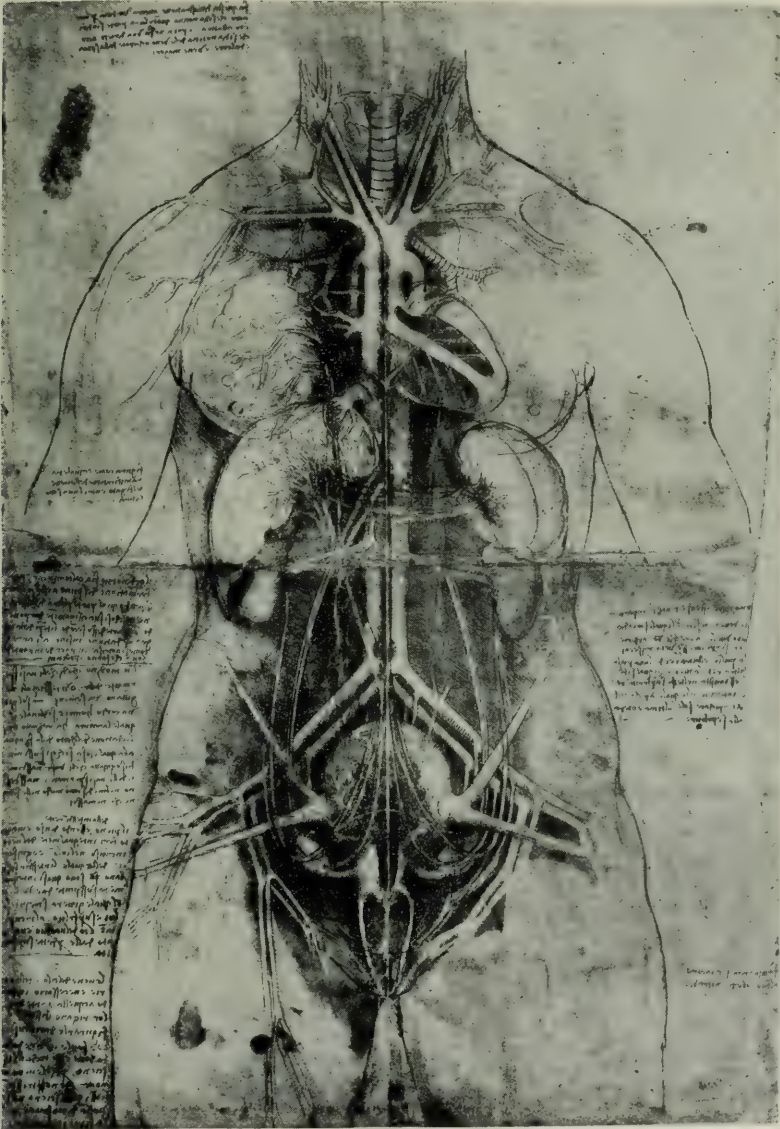
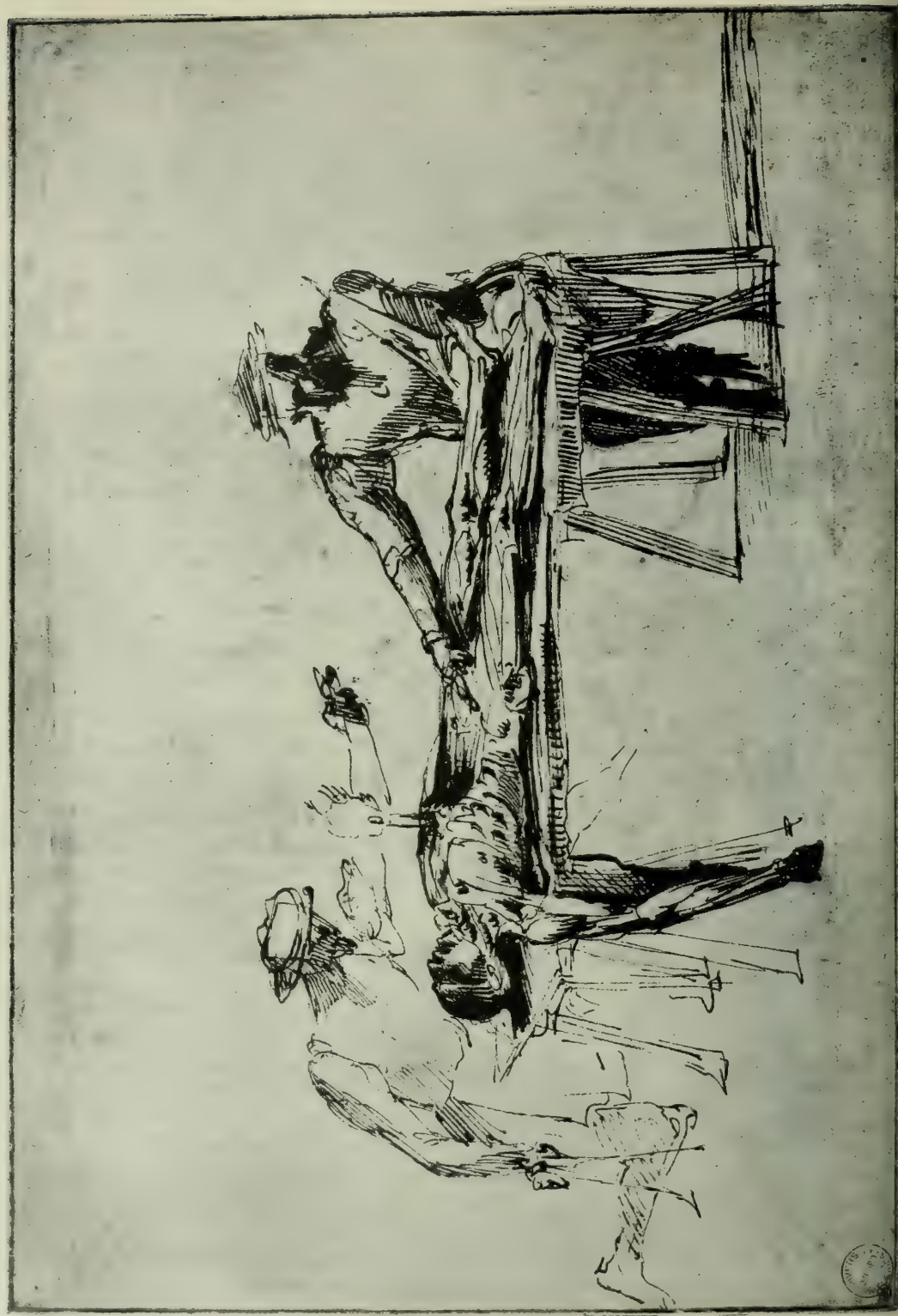


PLATE XXXV. VIEW OF THE INTERNAL ORGANS
LEONARDO DA VINCI

From a Drawing in the ASHMOLEAN MUSEUM, OXFORD, attributed to BARTOLOMEO MANFREDI (1574?-1602)



MANFREDI
1574-1602

of no less an authority than Galen. Furthermore he was the first to describe the vermiform appendix, and he gave the earliest correct account of several other organs, e. g. the choroid plexus and the olfactory nerves. He was an industrious dissector, and he tells us that he had examined more than a hundred bodies.

With Carpi we close our series of Bolognese anatomists. Into that group we now proceed to fit the writer with whom we are here specially concerned, Hieronymo Manfredi.

III. HIERONYMO MANFREDI

Hieronymo Manfredi was a member of a family that had already for more than two centuries provided distinguished citizens, and especially physicians, to the city of Bologna.¹ He was born about the year 1430 and was educated at the University of Bologna. Here in 1455 he was *laureatus* in Philosophy and Medicine, and here he became professor of the latter subject in 1463.²

During the second half of the fifteenth century, a perfect mania for the study of astrology infected Italy and penetrated equally into the Court, the Church, and the Academy. The profession of Medicine was far from immune, and at the University of Bologna, where a chair of Astrology had long been established,³ the study was pursued with ardour and enthusiasm. Here Manfredi early devoted himself to that will-o'-the-wisp, the pursuit of which absorbed and sterilized many of the best intellects of his day. By the year 1469 he was already regarded as an authority on the vainest of studies,⁴ and as the years went on he seems to have devoted himself to it ever more and more. The generally credulous character of Manfredi's astrological ideas may be

¹ Albano Sorbelli, *Le Croniche Bolognesi del Secolo XIV*, Bologna, 1900; *La Signoria di Giovanni Visconti a Bologna*, Bologna, 1901; Michele Medici, loc. cit., p. 4.

² Giovanni Fantuzzi, *Notizie degli scrittori bolognesi*, Tom. v, p. 196, Bologna, 1786.

³ Hastings Rashdall, *The Universities of Europe in the Middle Ages*, 3 vols., Oxford, 1895, vol. i, p. 244.

⁴ He is mentioned in this capacity by Niccolò Burzio, *Bononia illustrata*, Bologna, 1494. We have been unable to consult this work, which is quoted by Fantuzzi, loc. cit. See also Ferdinando Gabotto, *Bartolomeo Manfredi e l'Astrologia alla Corte di Mantova*, Torino, 1891, p. 19.

gathered from the page of his *Prognosticon ad annum 1479* which we here reproduce (Fig. 10).

The history of Manfredi's connexion with the University of Bologna may be briefly told. He appears for the first time on the professorial roll in 1462, when we find him giving the 'extraordinary' lectures on Philosophy, a subject then regarded as under especial charge of the physicians. In 1465 he was conducting the 'ordinary' course in Philosophy, and at the same time giving occasional lectures on Medicine. In the following year he was called to the chair of Theoretical Medicine, and in 1469 he helped the Faculty out of a difficulty by giving lectures on 'Astronomia' in place of the aged professor Giovanni de Fundis. The latter died in 1474, and from that date onward Manfredi assumed responsibility for the course on 'Astronomia'. Among the colleagues who joined him were Gabriele de Gerbi, who became lecturer on Logic in 1476, Filippo Beroaldo, who became lecturer on Rhetoric and Poetry in 1479, and Alessandro Achillini, who became lecturer on Logic in 1484.¹

Such was the regard for Manfredi's powers of astrological prediction that to all the University announcements of his course of lectures on Astronomy is added 'cum hoc quod faciat iudicium et tachuinum'.² In spite of his proficiency in the science, however, he was unable to foretell his own death. Giovanni Pico della Mirandola writes of him thus derisively:

'quo anno [1493] obiit omnimoda[m] uite incolumitate[m] fuerat pollicitus Hieronymus manfredus astrologus nostra aetate singularis: a quo tamen nihil mirandum minus praeuisam aliorum mortem: qui nec suam ipse praeuiderit: nam cum proxima estate uita sit functus: in istius tame[n] anni publico uaticinio qui scilicet] ei fuit fatalis: multa & mira sequenti anno dicturum se non semel pollicebatur. Qui nescio oppignoratam fidem quomodo reluet: nisi forte de caelo uerius nunc terrena despiciat q[uam] de terra oli[m] caelestia suspiciebat.'³

Manfredi died in 1493 and was buried in the church of Santa

¹ Manfredi's University career is extracted from Umberto Dallari, *I rotuli dei lettori legisti e artisti dello studio bolognese dal 1384 al 1799*, Bologna, vol. i, 1888, and Luigi Nardi and Emilio Orioli, *Chartularium Studii Bononiensis*, Imola, vol. i, 1907. ² See also P. A. Orlandi, *Notizie degli scrittori bolognesi*, Bologna, 1714.

³ Johannes Franciscus Picus Mirandula, *Disputationes aduersus astrologos*, Lib. ii, cap. 9, Bologna, 1495. Our quotation is from the original 1495 edition, not from the slightly variant *édition contrefaite*.

Margarita in Bologna. This church no longer exists, but it contained in the eighteenth century a tomb bearing the inscription :

HIERON. MANFREDO BONON. PHILOSOPHO AC MEDICO
 SVAE AETATIS NEMINI SECVNDO ASTRONOMORVMQVE
 CITRA INVIDIAM FACILE PRIMARIO.
 POSVIT SVPERSTES IOAN. FILIVS
 SVISQVE POSTERIS.
 VALE ATQVE ILLVM
 VALERE OPTA.¹

Manfredi left a widow, Anna, who was still living in 1496 with a household of ten persons in the Via S. Margarita.² The houses on one side of this street backed on the very walls of the buildings belonging to the 'University of Medicine',³ and we may suppose that Hieronymo Manfredi had resided here on that account. His surviving son, Giovanni, lived hard by in the Via S. Antonio di Padoa.

It cannot be said that Manfredi's printed works suggest great scientific attainments. All are permeated by the same astrological obsession. They comprise the following :

(a) The *editio princeps* of Ptolemy's *Cosmographia* and *Tabulae Cosmographiae*, the best-known printed work to which Manfredi's name is attached. He was associated in its production with the famous scholar Filippo Beroaldo, and the finely produced volume was published at Bologna in 1472 (?),⁴ and dedicated to the memory of Pope Alexander V (died 1410). It is interesting as containing the first printed map of England (Fig. 9). At the end of the work we read :

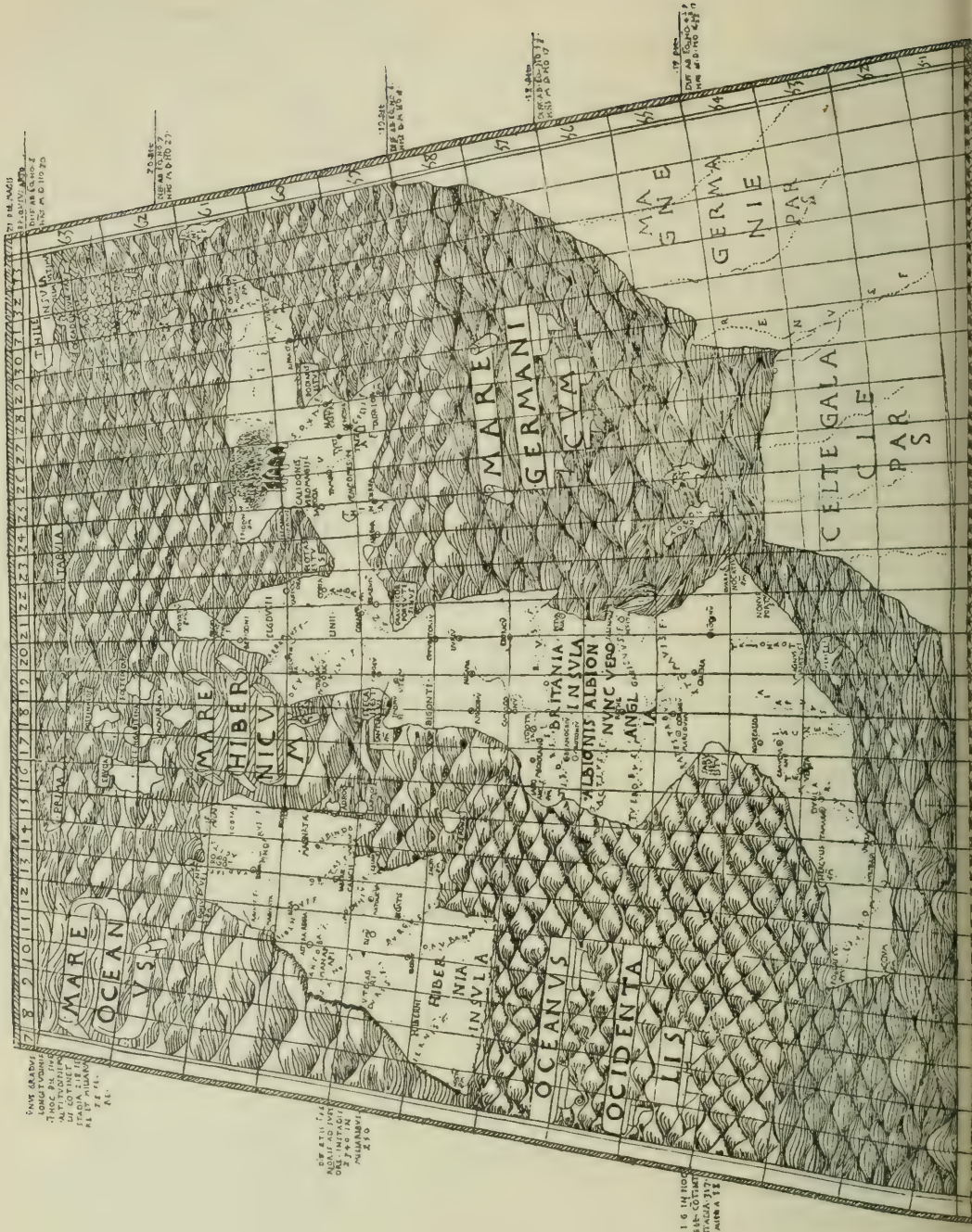
'Accedit mirifica imprimendi tales tabulas ratio. Cuius inuentoris laus nihil illorum laude inferior. Qui primi [itte]rarum

¹ G. Fantuzzi, loc. cit., p. 197.

² U. Santini, 'Cenni statistici sulla Popolazione del Quartiere di S. Proclo in Bologna', in *Atti e Memorie della R. Deputazione di Storia Patria per le Provincie di Romagna*, series 3, vol. xxxiv, pp. 366 and 367, Bologna, 1906.

³ See map of the old University buildings of Bologna prefixed to Francesco Cavazza, *Le Scuole dell' antico studio bolognese*, Milan, 1896.

⁴ The date 1462, clearly printed on this edition, is certainly erroneous, since there was no printing-press at Bologna till 1471. A. E. Nordenskiöld (*Facsimile Atlas till Kartografiens äldsta Historia*, Stockholm, 1889, p. 12) consider that 1472 is the true date, but the point is not yet finally settled. See J. A. J. de Villiers, 'Famous Maps in the British Museum', in *Geographical Journal*, vol. liv, London, August 1914, p. 173. Albano Sorbelli, in his authoritative *I Primordi della Stampa in Bologna*, Bologna, 1908, does not mention Manfredi's edition of Ptolemy among the earliest printed Bolognese works (1471-5).



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imprimendarum artem pepererunt in admirationem sui studiosissimum quemque facillime conuertere potest. Opus utrumque summa adhibita diligentia duo Astrologiae peritissimi castigaueru[n]t Hieronimus Mamfredus & Petrus bonus. Nec minus curiose correxerunt summa eruditione prediti Galeottus Martius & Colla montanus. Extremam emendationis manum imposuit philippus b[e]roaldus.'

(b) *Liber de homine: cuius su[n]t libri duo. Primus liber de conservatione sanitatis. . . .* [Liber secundus de causis in homine circa compositione[m] eius], Bologna, 1474. The work is in Italian, and consists of a number of paragraphs, each beginning with the word 'perchè'. There is a servile dedicatory epistle in Latin addressed to Giovanni Bentivoglio. The first book is concerned with diet, and occupies two-thirds of the volume. The second book answers questions on the subject of physiognomy and bears resemblance in many passages to the *Anatomy*. It is taken in the main from the pseudo-Aristotelian *Problemata*. The book is without pagination or figures. It is well printed, and illuminated examples are not infrequently encountered.

This work was very popular. In 1478, during the lifetime of its author, it was audaciously pirated at Naples with the following *incipit*: 'Incomenza el Libro chiamato della uita costumi natura & om[n]e altra cosa pertine[n]te tanto alla conservatione della sanita dellomo quanto alle cause et cose humane. Co[m]posto per *Alberto Magno* filosofo excellentissimo.'

In 1497, after Manfredi's death, the work appeared in black-letter folio at Bologna, with its author's original dedication slightly altered. The text in this edition commences, 'Perchel sophio nele cose che noi viuemo: & lo indebito modo del viuere nostro: induce in noi egritudine'.

In 1507 it appeared at Venice in small black-letter quarto as *Opera noua intititata Il perche utilissima ad intendere la cagione de molte cose*. By this title, *Il Perchè*, the work, which ran through numerous editions, has usually been known. It continued to be reprinted as late as 1668.

(c) A treatise on the Plague: *Tractato degno & utile de la pestile[n]tia co[m]posto p[er] el famosissimo philosopho medico & astrologo maestro Hieronymo di manfredi da Bologna*, Bologna, 1478. This was translated into Latin by the author himself in the same year. The work owes much to Avicenna, but contains

some original clinical observations, and shows a certain independence of the prevailing spirit of the age by quoting opinions of contemporary as well as of ancient physicians. The remedies

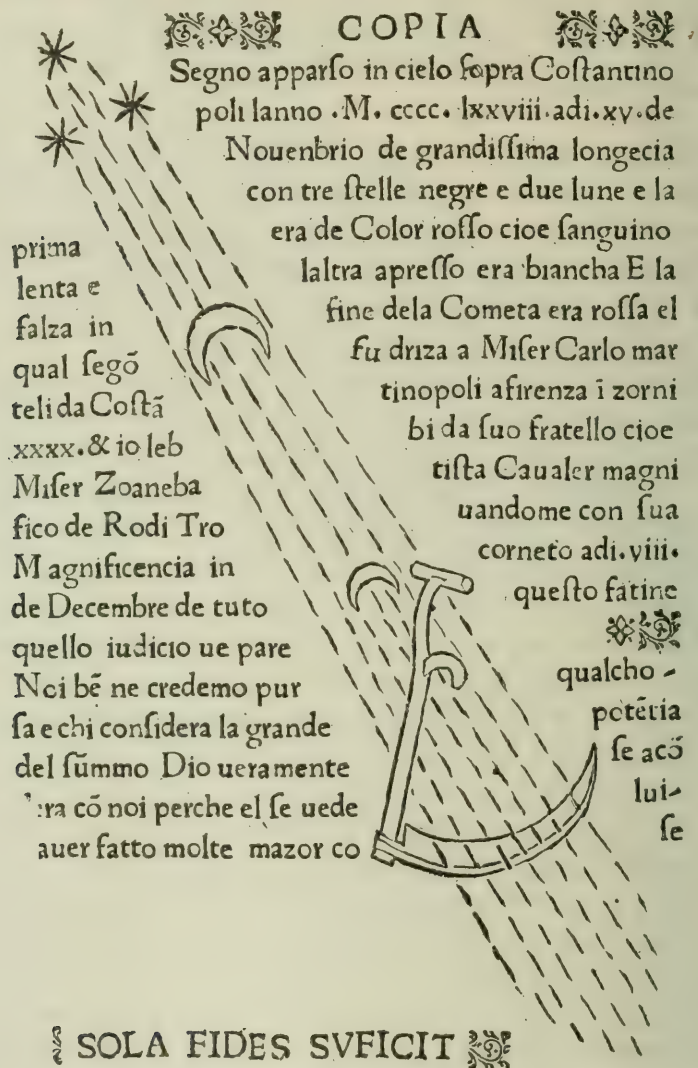


FIG. 10. The last page of Manfredi's *Prognosticon ad annum 1479*, Bologna, 1478.

are similar to those recommended by John of Bourdeaux in his widely distributed tract on the plague, and are probably derived ultimately from the *Regimen Sanitatis Salerni*.

(d) *Prognosticon ad annum 1479*, Bologna, 1478. We reproduce the terminal page of this work (Fig. 10).

(e) *Prognosticon anni 1481*, in which is embodied *Oratio contra turcos & hostes Christianorum*, s. l. Jan. 1481.

From his tomb in the Church of S. Giacomo Maggiore at Bologna



PLATE XXXVII. GIOVANNI BENTIVOGLIO II

BRIT. MUS. MS. ROY. 7 F VIII, fo. 50 v

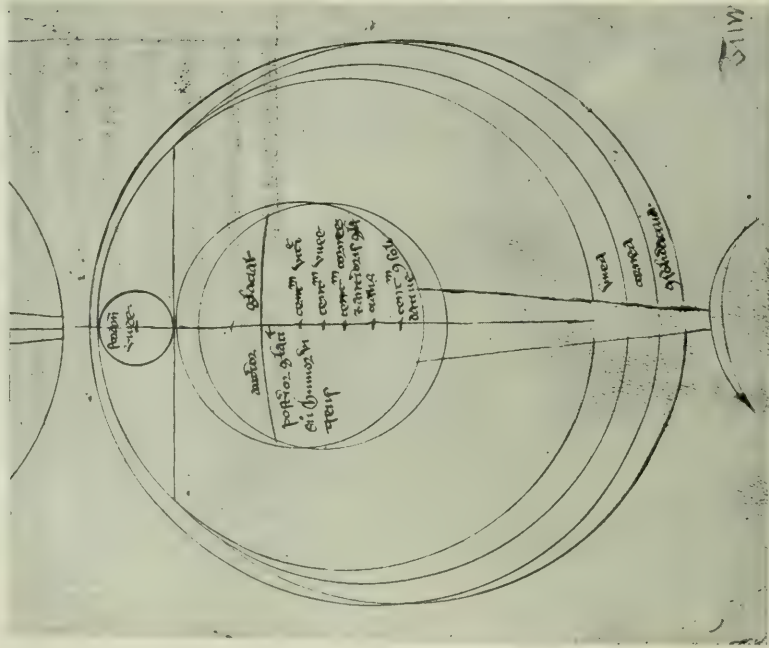


PLATE XXXVIII a. ROGER BACON'S
DIAGRAM OF THE EYE.
XIIIth Century

From a drawing in WINDSOR CASTLE

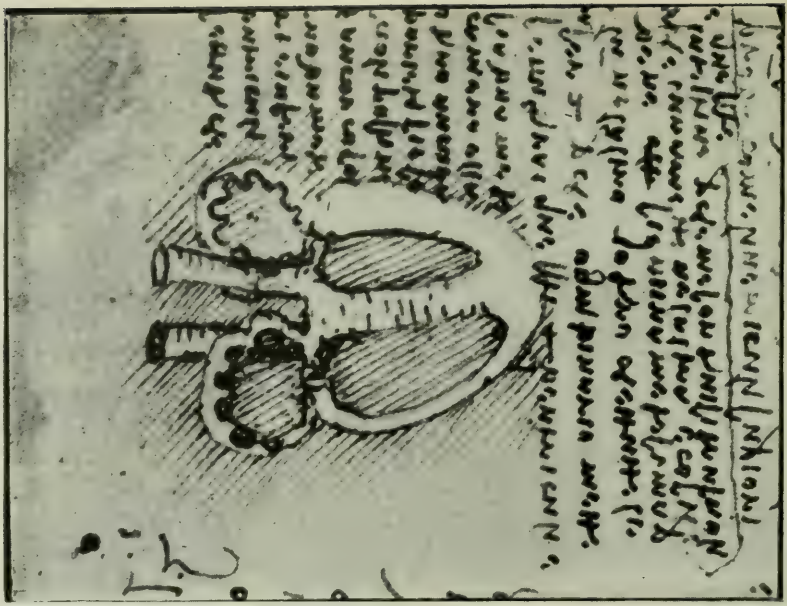


PLATE XXXVIII b. LEONARDO DA
VINCI'S DIAGRAM OF THE HEART
Early XVIth Century

(f) *Centilogium de medicis et infirmis*, Bologna, 1488. With a dedication to Bentivoglio. This short work is wholly astrological, and consists of one hundred precepts concerning the relationship of the stars to various diseases and conditions. Reprinted Venice, 1500, and Nuremberg, 1530.

The following three works are attributed to Manfredi, but are not mentioned in Hain, Copinger, or Reichling's lists of Incunabula; we have not seen any of them and their existence is doubtful.

(g) *Ephemerides astrologicae operationes medicas spectantes*, mentioned in the *Biographisches Lexikon der hervorragenden Aerzte* of E. Gurlt and A. Hirsch. Possibly it represents another edition of (e).

(h) *Quaestiones subtilissimae super librum aphorismorum*, Bologna, 1480 (?), mentioned by Haller.¹ Possibly it represents another edition of (b).

(i) *Chiromantia secundum naturae vires ad extra*, Padua, 1484, mentioned by Haller.¹

IV. THE MANUSCRIPT ANATOMY OF MANFREDI

The MS. of Manfredi's *Anatomy* is in the Bodleian Library at Oxford (Canon. Ital. 237, Western 20287). It is a fairly preserved small quarto parchment, originally of forty-nine folios, of which the third and fourth are missing. The writing is in the fine Italian hand that the printed type of the period was accustomed to imitate. There are no figures or illuminations, but the titles are rubricated in burnished gold or in colours.

There is no reference to this work in any account of Manfredi, and the volume itself appears to be quite unknown. Neither the man nor his work is mentioned in Medici's detailed history of the anatomical school at Bologna² nor in Martinotti's recent study on the same topic,³ nor is any MS. of Manfredi included in Mazzatinti's monumental catalogue of the MSS. in the Italian libraries.⁴

¹ Albrecht von Haller, *Bibliotheca anatomica*, Zürich, 1774-7, vol. ii, p. 738.

² Michele Medici, *Compendio storico della Scuola anatomica di Bologna dal Rinascimento delle Scienze e delle Lettere a tutto il Secolo XVIII*, Bologna, 1857, folio.

³ G. Martinotti, 'L'insegnamento dell'anatomia in Bologna prima del secolo XIX', in *Studi e Memorie per la Storia dell'Università di Bologna*, vol. ii, Bologna, 1911.

⁴ Mazzatinti, *Inventari dei Manoscritti delle Biblioteche d'Italia*, Forli & Firenze, 1890-1915, vols. i to xxiii, in progress.

Manfredi's MS. is written in the involved Italian of the day, with sentences of inordinate length. These general characters of style are encountered also in his published works. The dedication is in Latin, of the same unpleasing quality, and is couched in the usual subservient manner. It is addressed to Giovanni Bentivoglio, and in it Manfredi relates that

‘Your illustrious lordship Johannes Bentivolus in this present year 1490 with your usual humanity condescended on one occasion to watch the dissection of a corpse. . . . It was then that you saw the wonderful works of Nature in the anatomy . . . and you parentally urged me, Hieronymo Manfredi, to inscribe to your most noble name this work on anatomy. . . . I therefore extracted this work as best I might from various works of antiquity and abbreviated it. I have not followed their order, but I have so composed it that the work should be pleasing to your lordship.

‘Accept then, O great and powerful lord, this work on the anatomy of the human body inscribed to your noble name! Accept it with your customary benevolence and humanity and in a kindly and gracious spirit, for it will be pleasing to you and will delight you greatly, for it is a worthy work!’

The Giovanni Bentivoglio (Plate xxxvii), with adulation of whom Manfredi was thus accustomed to plaster his works, was the second of the name and was the son of Annibale Bentivoglio. In the year 1462 he became head of the republic of Bologna, and played there much the same rôle as did Lorenzo de' Medici at Florence. He adorned Bologna with numerous buildings,¹ and acted as patron of the arts and the sciences. The Palazzo dei Bentivogli still stands as a memorial to him and his family. A stern and high-handed tyrant, he held his position until 1506, when he was expelled and the city reverted to the papacy. He died two years later.

It is remarkable to find a man of Bentivoglio's eminence and position taking an interest in the practical study of anatomy. Other Italian rulers, Lorenzo de' Medici among them, encouraged and legalized the practice of dissection, but probably Bentivoglio is the only one recorded as having patronized an ‘anatomy’ in person. The interest taken in the subject by the heads of states must have been of great value to the artists whose patrons they were.

¹ Lino Sighinolfi, *L'Architettura Bentivolesca in Bologna e il Palazzo del Podestà*, Bologna, 1909.

The MS. is a unique copy, and was doubtless written for presentation to Bentivoglio. That it was never printed is perhaps due to the fact that Manfredi died within a comparatively short time of its composition. It represents the most satisfactory post-mediaeval account of the human frame until the appearance of the work of Berengario da Carpi in 1521. It is more complete than the work of William of Saliceto or of Mondino or the anatomy erroneously attributed to Richardus Anglicus; it is more natural than the book of Gabriele de Gerbi, and is far superior to the crude contemporary sketches of Hundt, Peyligk, and Achillini, while it wastes less space than Guy de Chauliac on teleology, though it has none of the charm of the work of that great surgeon. In one respect at least, viz. the spirit in which it is written, Manfredi's *Anatomy* is original and probably unique for its age. There is no reason to doubt the assurance of the dedication that it was composed for the edification of the tyrant of Bologna, and for the simple purpose of setting forth the wonderful structure of man's body without thought of any medical application.

The sources of the MS. are obvious. It is in the main a re-arranged and on the whole improved Mondino, but amplified by reference to translations from Galen, Rhazes, Haly Abbas, and Avicenna. Guy de Chauliac has perhaps also been used. The work gives a general impression of being the product of a practical dissector, and it provides us with a good example of early Renaissance anatomy as taught in the Italian schools before the reforms of Vesalius. It is perhaps the first complete treatise on its subject written originally in the vernacular.¹ It exhibits, however, no other original features nor any considerable departures from its sources, and it may be taken to represent, with but little modification, the tradition of Mondino as developed at his own University of Bologna at the end of the fifteenth century.

Manfredi's work, however, if not original is at least eclectic, and the variety of its sources indicates a dawning consciousness of the unwisdom of trusting to the infallibility of any one writer. The work is thus in a sense intermediate between the early printed versions of Mondino, such as that of 1478, and the edition

¹ Several short sketches or tractates on anatomy in the vernacular are however known. Thus a Provençal anatomical tractate of the thirteenth century has been published by K. Sudhoff in his *Beitrag zur Gesch. der Anatomie im Mittelalter*, Leipzig, 1908.

published in 1528 by Berengario da Carpi with its frank commentary of the master. All represent stages towards the freedom of the later Renaissance investigators.

We reproduce the text in full, and the passages on the head, on the eye, and on the heart, are rendered into English. All are similar to the accounts of Mondino. We are able to illustrate them by figures from contemporary works, and thus to give an idea of the limits of the anatomical knowledge of the day.

V. TRANSLATION OF SELECTED PASSAGES FROM THE ANATOMY, WITH COMMENTARY

(a) THE HEAD

Tractate i, Chapter 2

(folio 5 verso) There are ten layers of the head.

The *first* is the *hair* made by nature for the better protection of the head from external things, and also for beauty.

The *second* part is the *skin*, which has here to be very thick, so that the hair may be firmly embedded, having its roots thick and long; and also to be a better shield and covering for the bone and brain, since there is no muscular part here.

The *third* part is the *flesh*, developed only on the face, the temples, and about the jaws, not on the other parts.

The *fourth* part is an external membrane called *almochatim* [Arabian term for cranial periosteum] which, when the skin is raised, appears to be continuous and covers the whole cranium. And nature made this membrane firstly so that the skin which is soft should not come into contact with the hard bone, secondly that the bone of the head should have sensation through it, and thirdly that the internal membrane of the head, called *dura mater*, should, by means of this membrane, be attached to the bone of the cranium by certain nerves and ligaments. These, issuing through the commissures of the bones, have thus their origin in the aforesaid internal membrane, while on emerging through the bone, they weave themselves into or rather compose the external membrane called *almochatim*.

The *fifth* part is the *skull*. This is a bone like a cap, inside the cavity of which is located the brain. In the skull are four bones sutured together. Nature made the skull not of one but of many pieces, firstly, so that if harm should fall on one part it

might not spread to the others; secondly, so that by their joints or rather sutures [Italian *cusiture* = sewings], the humours of the brain might be the better exhaled; and thirdly, so that when there is need of applying medicines, these might the better penetrate to the parts within.

Hence it is that four pieces of bone are sutured and joined together by nature in a denticulate fashion, so that they might be the firmer and stronger. Nor are they bound with ligaments as are the joints, for these would not have been so strong, and furthermore the bones of the head do not need to move.

These sutures are five in number, three being true and two false. The true sutures are those which pass right through the bone, while the false do not. Of the true sutures one is in the anterior part and is called *coronal*; it is made like the letter C, and stretches from right to left of the head, the two wings of the C being directed towards the forehead. The second true suture extends along the length of the head, beginning from the coronal and reaching the back part of the head. It is like a shaft or rather arrow that goes backwards from the brow, wherefore it is called *sagittal* —(. The third true suture is in the posterior part and is called *laudal*, for it is made like a Δ , the letter called by the Greeks *lauda*. The sagittal suture extends from the coronal to the lauda)—(.

The false sutures are two, one on each side. They are called *cortical* because they do not penetrate.

Now if we consider these five sutures we shall see that there are four bones articulated together. One is the forehead bone [frontal] which begins at the coronal and ends below at another suture, which itself begins as a branch of the coronal suture and proceeds by way of the eyebrow to the corresponding branch [of the other side] G.

A second bone is behind and terminates at the laudal suture. There are two other bones which form the temples. These terminate at the false sutures which themselves begin at the laudal and end at the coronal suture.

The *sixth* part [of the head] consists of two membranes. One of these is called *dura mater*, and lies in contact with the cranium. The other is called *pia mater* and is in contact with and covers the brain. And nature contrived it thus, having great solicitude for this latter member, that while close to the bone, it should

yet not be touched by it. Wherefore, taking due precautions, she made the one [membrane] harder than the other. Furthermore she made two membranes, so that if harm befell one of them, it might not be communicated to the underlying brain.

In the *pia mater* are woven certain veins by which the brain is nourished. [The brain is] everywhere covered by it except on the posterior part; because this part being dry, it has no need of this membrane, as have the anterior and middle parts. The two membranes in many places penetrate the substance of the brain, dividing it into a right and a left, a front and a back section. By this division, divers cells or rather small chambers are made therein, in which the soul (*anima*) performs its divers operations, for which reason it is necessary that these parts should be of different structure.

When the two membranes are raised, the *seventh* part of the head, namely the brain itself, appears. The brain is wrought by nature so that the *vital spirit* from the torrid heart should be tempered by its cold, for here it is converted into *animal spirit*, which is the beginning of the perceptive (*cognoscitive*) and motive processes.

The brain is of a substance like marrow, white, soft, and viscous, and from it the nerves arise. The anterior part is moister, softer, and less cold than the posterior because the senses [*senti-menti* = senses + mental processes], which are themselves moist and soft, have here their origin. In the posterior part the motor nerves arise, and it is therefore drier and firmer.

The brain is divided into three parts or ventricles. The first ventricle or anterior part is itself divided into two, right and left, and is moreover larger than any of the other ventricles, for in this first ventricle nature has placed the two faculties subservient to perception (*al cognoscere*). One of these is called *common sensation* (*senso comune*); in it the external senses terminate as at a centre and deliver the *images* or rather *species* of sensible things, so that this faculty may perceive and distinguish between one sensible thing and another, and also comprehend the operations of particular senses; which two things none of these [senses of themselves can do]. The other faculty of the first ventricle is called *fantasia* and by some *imagination*; it retains and preserves the *species* of sensible things in the absence of the material objects themselves.

When thou examinest the first ventricle thou wilt see three things before thou comest to the second ventricle.

[a] The first is itself double, and is formed of the very substance of the brain, so that it forms the base of the anterior ventricle both right and left [= corpora striata].

[b] To the side of this is another thing like a subterranean worm, red as blood, yet tethered by certain ligaments and nervelets [= choroid plexus and taenia semicircularis]. And this worm when it lengthens itself closes these passages, and thus blocks the path between the first ventricle and the second. Nature has wrought it thus, so that when a man wills he may cease from cogitation and thought; and similarly when, on the other hand, he would think and contemplate, this worm contracts itself again and opens these passages and thus frees the way between one ventricle and another.

[c] The third structure is a little lower and is a *lacuna* or rounded concavity [= infundibulum]. In the middle of this is a hole which passes down towards the palate, and this lacuna provides also a direct passage which descends from the middle ventricle to its *colature* [= sieve-like structure, i. e. certain parts of the sphenoid bone]. And this lacuna has around it certain large round eminences which support the veins and arteries that ascend to the ventricle. This passage is wide above and narrow below, and by it the first and second ventricles purge themselves of their superfluities, but the anterior part [of the first ventricle] purges itself more by the colature of the nose [= cribriform plate]. Thus nature has made two passages to cleanse the superfluities of the brain.

When thou hast seen these three structures there will appear the second or middle ventricle which is as a passage and transit from the anterior to the posterior ventricle. Here are two faculties. One, the *estimative*, deduces [Italian *elicere*] the insensible from the sensible. The other, called the *cognitive*, comprehends both things sensible and things insensible, synthesizing and analysing them (*componendo e dividendo*). These [two] faculties in the middle ventricle minister to the intellect. Now all the other faculties described, and even the power of memory, are found in brute animals, but this [intellectual power] is encountered in man alone.

Now will appear the third ventricle in the posterior part; and it is hard, for it gives rise to the greater part of the motive

nerves which are of a strong and firm nature. This ventricle is pyramidal in shape, and culminates in an apex directed upwards where images of visible things (*spetie*) are conserved, for these are better stored in a strait than in an ample space; but the part below is wide to receive these images, which are better received in an ample than in a strait place. This ventricle has two functions: it gives rise to the spinal cord [*nucha*, an Arabian term] and motor nerves; and it is also the storehouse of the *memorative* faculties.

From what [has been said] it will be apparent that when the back of the head is injured, the memory immediately suffers; when the middle part is injured, the estimative and cognitive faculties suffer; and when the anterior part is injured, the faculties of common sensation and of imagination (*fantasia*) suffer. And thus it is that the doctors have become aware of the location of these powers.

This being disposed of, thou wilt next raise the brain carefully so as not to break the nerves. Commencing now with the part in front, there will first appear two small fleshy protuberances like two nipples, of like substance to the brain in which they originate, and covered by a thin membrane, the *pia mater*. These are the olfactory organs, wherein is the sense of smell.

From the brain arise seven pairs of nerves. Proceed therefore farther with the anterior part, and thou wilt see the first pair of these nerves, which are large, and called the *nervi optici*. These have their origin in the front ventricle of the brain and proceed towards the eyes. But before they pass through the *pia mater*, they join together, and at their place of union there is a perforated spot. Galen maintains that these nerves only join or rather unite, but do not intersect, so that the nerve that comes from the right after union returns again towards the right, and similarly with the nerve coming from the left, which after the union returns towards the left eye.¹ But Rhazes maintains the contrary,² although the opinion of Galen is the more common. These nerves are subservient to sight, and they are united so that the images of the things received by the two eyes and conveyed by the two nerves should return in unity; so that one thing should not appear as two.

¹ Cf. Galen, *De usu partium corporis humani*, Lib. x, chap. 12.

² Cf. Rhazes, *Almansur*, i. 4.

After these two nerves, raise the brain towards its middle and thou wilt see another pair of nerves, thin and firm, which also go to the eyes, to give them voluntary movement, controlling certain muscles.

Farther on thou wilt see the third pair of nerves, one part of which goes to the face to give it sensation and voluntary movement, while another part goes to give taste to the tongue. Yet a third part of these nerves mingles with the fourth¹ pair of nerves, and together they descend to give sensation to the diaphragm, stomach, and other viscera. A certain part also of the fourth¹ pair of nerves goes to give sensation to the palate.

Then there is the fifth pair of nerves [which] go to the *petrous* bone around the ear; and of these nerves there are framed in the ear-holes certain membranes, which are the organs of hearing.

Next there is the sixth pair of nerves, which divides into three parts. One part goes to the muscles of the throat, the second to the muscles of the shoulders, and the third and largest descends to the epiglottis and to the diaphragm, and spreads into the chest, the heart, and the lungs, accompanying the nerves of the third pair. From the nerves of this sixth pair which go to the epiglottis arise the nerves of the voice, called *reversive*.

The seventh pair of nerves arise at the back of the brain and give voluntary movement to the tongue.

Of these seven pairs of nerves, the first two pairs originate in the anterior part of the brain, the third pair originates between the anterior and posterior parts, while the remaining four pairs originate in the posterior part.

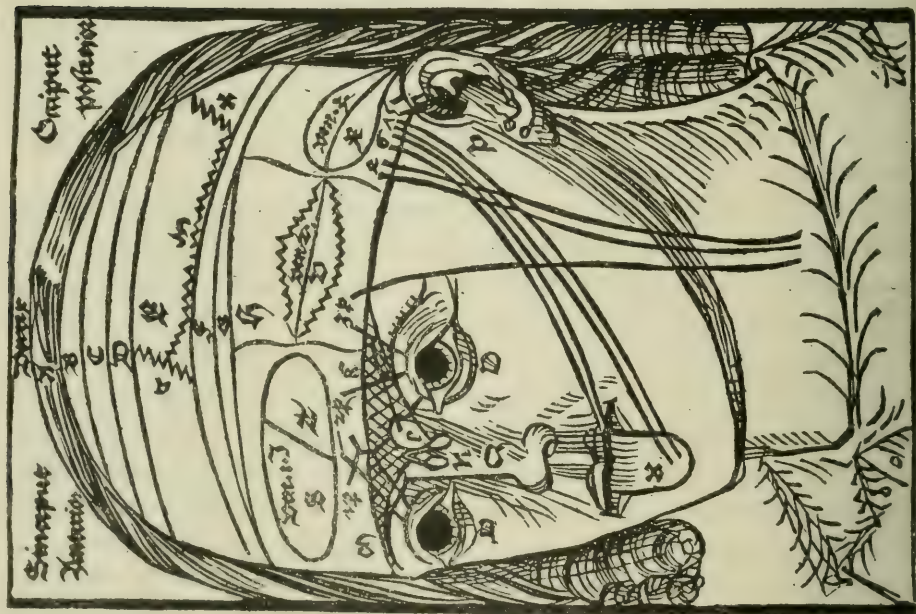
Proceeding still farther, the brain may be completely raised, and the eighth part of the head will appear, that is, the two membranes situated below the brain. When these in turn are raised there will appear the ninth part, which is a certain net called *rethe mirabile*, because it is composed of exceedingly strong and marvellous texture, augmented by certain very fine arteries which are branches of arteries that ascend from the heart, and are called the *apoplectic arteries*. In these arteries of this net is contained the vital spirit, sent from the heart to be changed to animal spirit. That the spirit may be the better modified and distributed, nature made these arteries very fine, and separated

¹ Manfredi here follows Mondino, who confuses Galen's fourth pair with Galen's sixth pair of nerves.

S
Sensus
I
Imaginatus

I
Intellectus

A
Logicatus
I
Memoratus



- B Capiti
- D Luto
- C Caro
- D Panicle
- E Cranii
- F Dura mf
- G Pia mater
- H Cerebri
- I pmo
- K Cerebri sco
- R Rete mirabile
- Z Lacuna
- M nervoz paria
- N Cerebri
- O Tricus
- P Audis
- Q Olfactus
- R gustus
- v Locomotio
- Z Sensus
- + Locus

Lacus per totum corpus exiit per nervos spondylium.

FIG. 11. From M. Hundt, *Antropologium, de hominis dignitate natura et proprietatibus*, Leipzig, 1601. The figure shows the ten layers of the head, the cerebral ventricles and cranial nerves, and the relation of the nerves to the

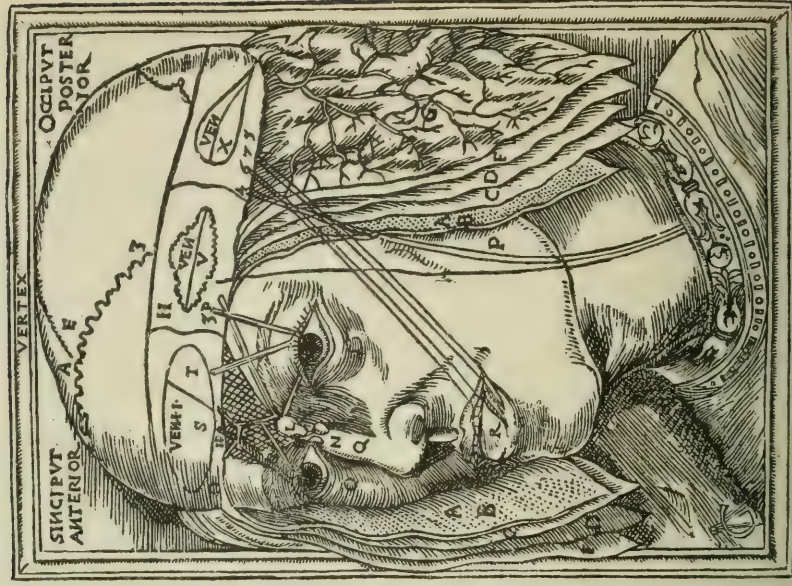


FIG. 12. THE LAYERS OF THE HEAD
From the *Anatomia* of Johannes Dryander, Marburg, 1537.

them into very small branches so that the spirit should be minutely divided. Nature placed the rethe mirabile under the brain because it was necessary to guard its site carefully, and also that the moist vapours of the brain which fall upon the net, obstructing it, should induce natural sleep.

After all these things thou wilt see the basal bone which is the tenth and last part of the head, and called *basilar*, because it is the base and foundation of the whole head; and it was made hard so that the superfluties which descend to it should not putrefy it. This bone can be seen to be formed of many other bones articulated together. It is divisible into the petrous bones and the bones of the nose and eyes and two other lateral bones which can only be seen by means of disarticulation. [Folio 10 verso, line 22.]

The ten parts or layers of the head are a commonplace of the anatomy of the period, taken from Avicenna. We may illustrate the division by the crude contemporary diagram of Fig. 11, which is improved in the later drawing reproduced in Fig. 12.

Manfredi's account of the brain itself is amplified from Mondino. The division of this organ into three ventricles, each associated with a corresponding division of the mental functions, was very familiar to medical writers of the fifteenth century. The idea is found among Western writers as early as St. Augustine (354-430), and is encountered in the writings of Roger Bacon (1214-94). It had long been popularized in mediaeval psychology by the writings of Albertus Magnus (1206-80). The anatomical distinction is found in Haly Abbas, Avicenna, and Rhazes, and in some of the best MSS. of the latter writer a rough diagram of the ventricles is given.¹ These writers are all clearly indebted to the anatomy of Galen,² but on the psychological side Albertus Magnus probably drew mainly either from Ghazali³ (1059-1111), who in turn derived his inspiration from Nemesius (fourth century) and Johannes Damascenus (died 756), or else from

¹ See P. de Koning, *Trois Traités d'Anatomie arabes*, Leyden, 1903, p. 47.

² See J. Wiberg, 'The Anatomy of the Brain in the Works of Galen and 'Ali 'Abbas; a comparative historical-anatomical study', *Janus*, vol. xix, p. 17 and p. 84, Leyden, January and March, 1914.

³ See A. Schneider, 'Die Psychologie Alberts des Grossen', p. 160, in *Beiträge zur Geschichte der Philosophie des Mittelalters*, Band iv, Heft 5, Munich, 1903.

De anima.



FIG. 13. From *Illustrissimi philosophi et theologi domini Alberti magni compendiosum insigne ac perutile opus Philosophiae naturalis*, Venice, 1496, showing the ventricles of the brain.

early writers of the Salernitan tradition, such as Constantine¹ (eleventh century), or Petrocello² (twelfth century), who drew largely on Theophilus (seventh century).³

This outline of a tripartite division of the brain and its cavities was closely followed throughout the Middle Ages, as was also the curiously naïve and excessively 'materialistic' psychology to which it gave rise, and which Manfredi adopts. We illustrate his views of the relationship of the different parts of the brain and their parallelism in mental processes, from a series of diagrams extracted from contemporary works (Figs. 13-18).

The brain was

¹ Constantine Africanus, *De communibus medico cognitu necessariis locis*, Lib. iii, cap. 11, Edition Henricus Petrus, Basel, 1541.

² *Practica Petrocelli Salernitani. Epistola. Quot annis latuit medicina*. S. de Renzi, *Collectio Salernitana*, Naples, 1852-9, vol. iv, p. 189.

³ A very elaborate study of the doctrine of the three vesicles of the brain has recently been made by Walther Sudhoff, 'Die Lehre von den Hirnventrikeln', in the *Archiv für Gesch. der Med.*, Leipzig, 1914, vol. vii, p. 149.

regarded by mediaeval and early Renaissance anatomists as having two channels of discharge through which the *phlegm*, the especial product of this organ, could be evacuated when in excess. One of these channels communicated with the anterior ventricle of the brain and poured its secretion into the nose. It may be identified with the *anterior colature* or cribriform plate. The second, the *lacuna*, led down from the second ventricle and poured its secretion into the pharynx. It may be identified with the infundibulum, pituitary body, and 'cella turcica'. The term 'pituitary' which we still use is derived from its supposed association with the 'pituita' or phlegm. At an early date this process was connected with the four humours (Fig. 14). The rest of the description of the brain can be easily followed. The comparison of the choroid plexus to a worm is very common. The suggestion originated with Galen and was developed by the Arabians.

COMPARATIVE TABLE OF ANCIENT AND MODERN NOMENCLATURE OF CRANIAL NERVES.

<i>Mondino and Manfredi following Galen, especially in the περι χρείας τῶν ἐν ἀνθρώπου σώματι μορίων. De usu partium corporis humani.</i>	<i>Modern usage.</i>
Not regarded as separate nerves.	I. Olfactory nerves.
I. τὰ μαλακὰ νεύρα τῶν ὀφθαλμῶν.	II. Optic nerves.
II. τὰ κινητικὰ τῶν ἀμφ' αὐτοὺς μυῶν.	III. Oculomotor nerves.
Not mentioned.	IV. Trochlear nerves.
III. τρίτη συζυγία. } IV. τετάρτη συζυγία. }	V. Trigeminal nerves.
Mondino and Manfredi confuse Galen's fourth pair and Galen's sixth pair.	
Not mentioned by Manfredi. By Galen probably united with II.	VI. Abducent nerves.
V. πέμπτη συζυγία.	{ VII. Facial nerves. VIII. Auditory nerves.
VI. ἕκτη συζυγία.	{ IX. Glossopharyngeal nerves. X. Vagi. XI. Accessory nerves of Willis.
VII. ἑβδόμη συζυγία.	XII. Hypoglossal nerves.

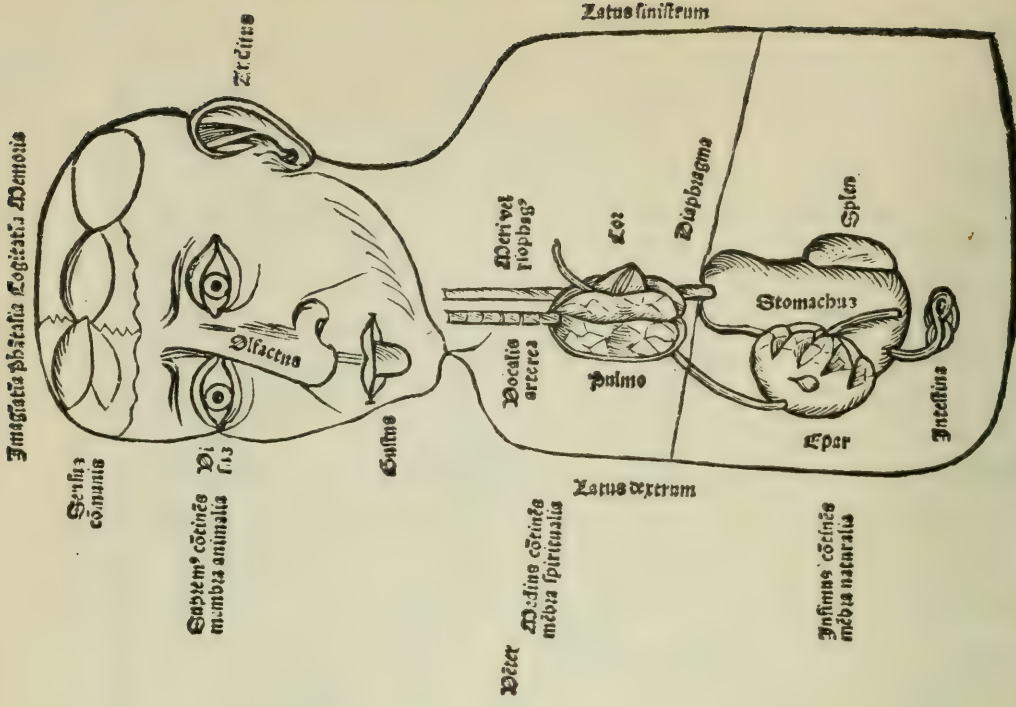


Fig. 15. From K. Peyligk's *Philosophiae naturalis compendium*, Leipzig, 1489. Illustrating the general ideas on anatomy current at the Renaissance.

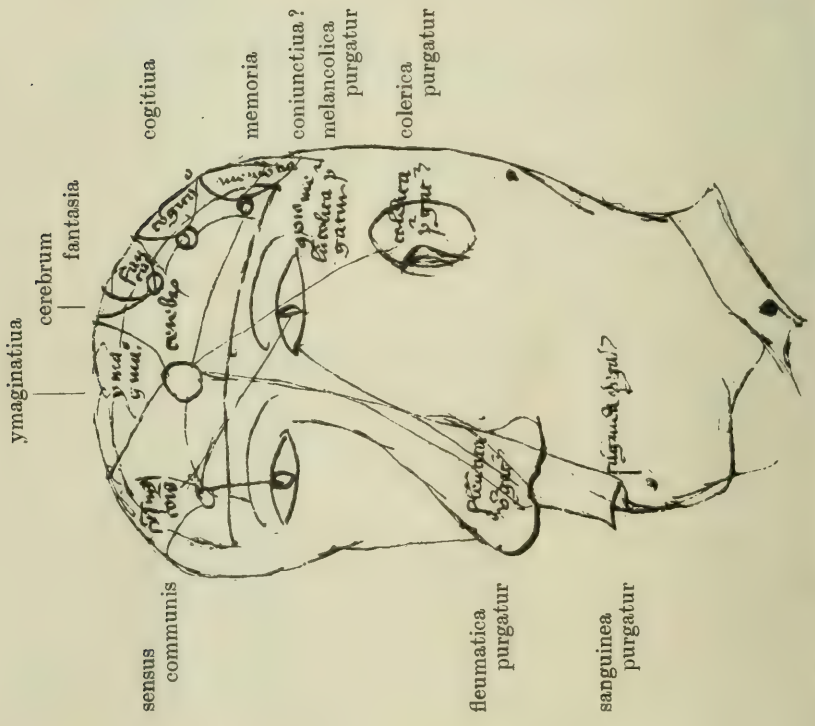


Fig. 14. Diagram of the senses, the humours, the cerebral ventricles, and the intellectual faculties. MS. Sloane 2156, folio 11 recto, in the British Museum, being a copy written in 1428 of the *De Scientia Perspectiva* of Roger Bacon.

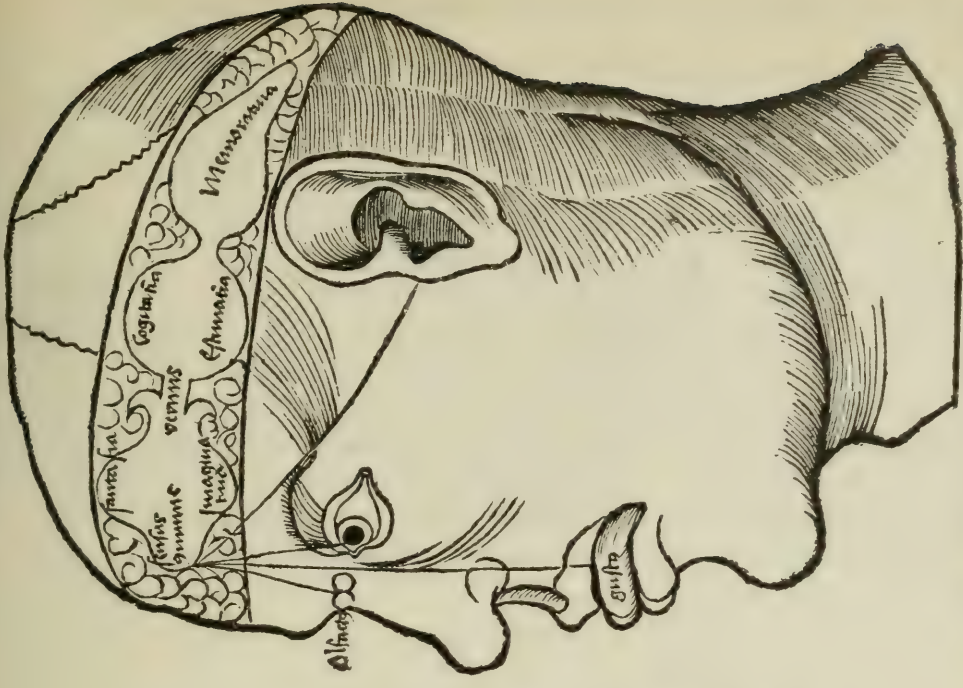
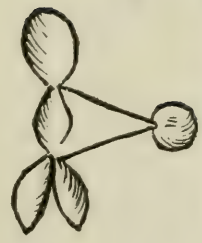


Fig. 18. From G. Reisch, *Margarita philosophica*, Leipzig, ? 1503. Diagram of the ventricles and the senses with their relation to the intellectual processes according to the doctrine of the Renaissance anatomists.

Ventriculi cerebri



Anterior Medius Posterior



Lacuna cerebri

Fig. 16. The cerebral ventricles from above and from the side. According to K. Peyligk, *Philosophiae naturalis compendium*, Leipzig, 1489.

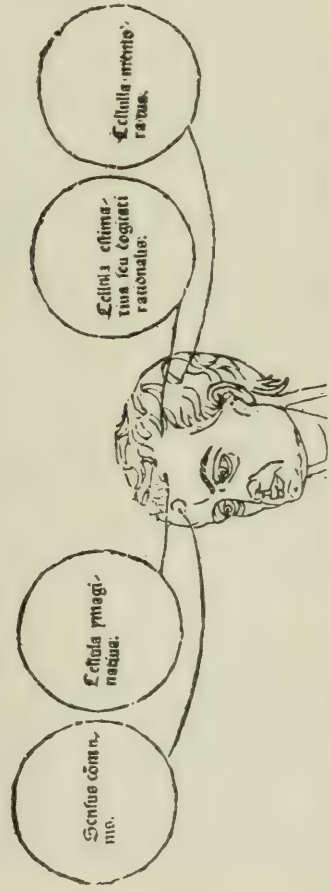


Fig. 17. The localization of cerebral functions. From the Italian edition of 'Ketham', *Fasciculus Medicinæ*, Venice, 1493.

The nomenclature of the cranial nerves adopted by Manfredi is taken from Mondino and is almost identical with that of Galen, whose classification is summarized above.¹ Manfredi's description of Galen's fourth pair is confused and inadequate, but his account of Galen's sixth pair is an improvement upon Mondino.

The 'rete mirabile' is an interesting survival of Galenic anatomy. This structure is hardly present in man, but is developed in the lower animals, and especially in calves, upon whose bodies Galen worked. The father of physiology regarded the 'rete mirabile' as the place where the psychic pneuma was elaborated.² Galen's findings in the lower animals were assiduously transferred to the human body, to which his descriptions are much less applicable, while his views on the pneuma lasted in more or less misunderstood form well into the seventeenth century.

(b) THE EYE

Tractate i, Chapter 3

(folio 11 recto) The socket of the eye is not over-depressed, for it has to receive the images (*spetie*) of visible things. Nor does it project greatly, lest it should be liable to injury from exterior violence. For the eyes of man being very soft and susceptible, nature provided eyebrows as a shield above, and eyelids as protectors in front, and made moreover the projections of the maxillae and the nose, so that the eyes should be guarded on every side. So great was the solicitude of nature for these members.

Seven are the tunics of the eye and three its humours. Three front coatings join with three coatings at the back like six shields, the edges of every pair joining each to each, the outer being larger and containing the others. The seventh tunic is largest of all, and encloses the whole eye, and therefore it is called *conjunctiva* because it joins and surrounds the whole eye except the place where the pupil is, and that small part [is covered] by the

¹ See F. G. A. Stumpff, *Historia nervorum cerebralium ab antiquissimis temporibus usque ad Willisium nec non Vieussensium. Dissertatio inauguralis*, Berlin, 1841; C. Daremberg, *Œuvres anatomiques, physiologiques et médicales de Galien*, Paris, 1854, p. 583, &c.; G. Helmreich, ΓΑΛΗΝΟΥ, *περὶ χρείας μορίων*, Leipzig, 1909; and Theodor Beck, 'Die Galenischen Hirnnerven in moderner Beleuchtung', in *Arch. für Gesch. der Med.*, vol. iii, p. 110, Leipzig, 1910.

² Galen, *De usu partium*, ix. 4; *De Hippocratis et Platonis decretis*, vii. 3.

cornea. Now this first tunic where it covers the outside part is seen to be white.

The second tunic in its front part is called *cornea* because it resembles horn in its substance and colour ; and this covering is transparent, so that the images of visible things may penetrate through it. And it is also solid and large and composed of four membranes, so that being near external things it should not receive hurt. With this [corneal tunic] is united posteriorly another tunic [the third] called *sclerotic*, i. e. hard. These two coverings have their origin in the membrane about the brain, that is in the *dura mater*, just as the first tunic arises from the membrane over the skull, called *almochatim*.

The fourth tunic as to its front part is called *uvea* [because] it is like a seed of a black grape, and in its midst is a hole called the pupil. Nature made this tunic opaque so that the visual spirit should be conserved and not dissipated by the light outside. Moreover nature made the opening in the tunic that the image might penetrate freely ; while it is narrow, so that the visual spirit should be concentrated. Thus when the said pupil, or rather hole, dilates more than usual, either naturally or accidentally, the sight becomes imperfect. [The uveal tunic] joins posteriorly the fifth tunic, called *secundina* because it is made like the after-birth, i. e. the membrane in which the child is enveloped in its mother's womb, and it arises from the *pia mater*.

The sixth coating in front is called *arachnoid* because it is formed after the manner of a spider's web, and posteriorly it joins the seventh coating, called *retina*, because it is made like a net.

Between the uvea and the arachnoid anteriorly there is a humour called *albugineus*, like the white of an egg, to moisten the eye and to preserve the convexity of the cornea. In a dead man this humour dries up, and the cornea falls and is flattened, and then the vulgar say that there appears a curtain before the eyes which is an infallible sign of death. Also this humour holds the pupil open ; therefore when it dries up the pupil contracts.

Between the two last tunics, i. e. the arachnoid and the retina, which have their origin from the optic nerve, there are two humours. These are the *vitreous* humour, so called from its likeness to liquified glass, and the *crystalline* humour, from its likeness to a crystal. This is also called the *grandid*, because it is like a hailstone ; and it is somewhat hard and round, but flattened

anteriorly where it receives the images of visible things, and posteriorly pyramidal shape and pointed. And here is completed the act of seeing. In the posterior part it is surrounded by the vitreous humours by which it is nourished. The crystalline

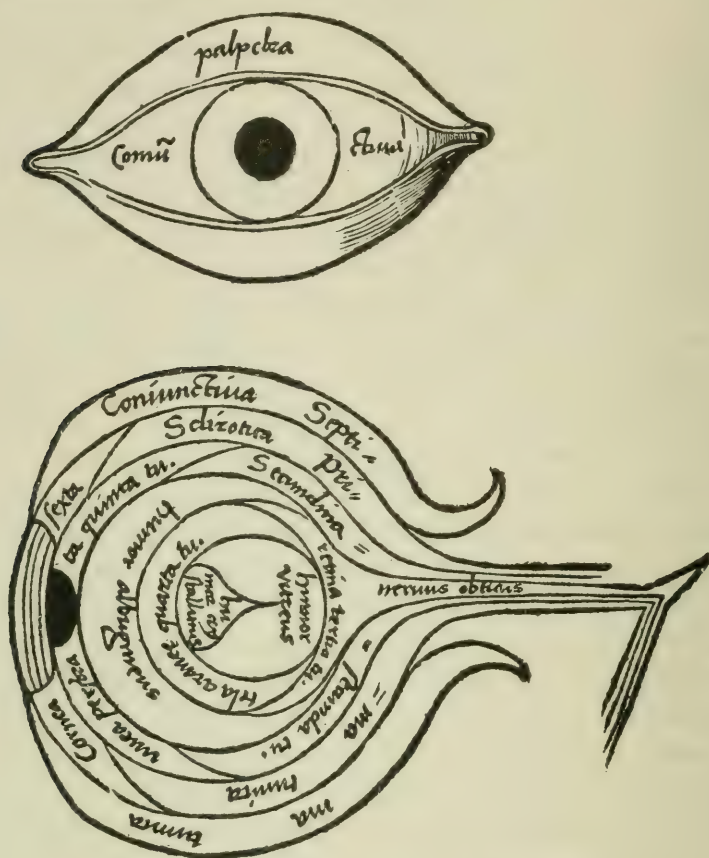


FIG. 19. THE ANATOMY OF THE EYE

From G. Reisch, *Margarita philosophiae*, Leipzig, ? 1503. Showing the seven tunics and three humours of the eye according to the doctrines of Renaissance anatomists.¹

humour is convex anteriorly and the vitreous posteriorly. And the optic nerves come to the eyes and convey the images seen by the eyes to [the seat of] common sensation and to the other internal faculties. [Folio 12 verso, line 7.]

A great deal of attention was paid by the Arabians to the diseases and the structure of the eye, and the essentials of Manfredi's description are to be found in Rhazes, Hunain ben Ishak,

¹ The first edition of the work appeared in 1496.

and Haly Abbas. The tradition presented by these writers passed early into Western science, and is reproduced, for example, in the works of Constantine Africanus and in the well-known anatomy to which the name of Richardus Anglicus (Richard of Wendover) has become attached¹ (cp. Fig. 19). Avicenna's description of the eye is somewhat different, and gave rise to the tradition reproduced in the works of John of Peckham and of Roger Bacon (Plate xxxviii a), and it influenced the views of Leonardo and even perhaps of Vesalius (Fig. 20). The views on the anatomy of the eye expressed by Rhazes, Hunain ben Ishak, and Haly Abbas were, on the whole, more widely accepted than those of Avicenna.

The treatment of the eye was always felt to be hardly within the range of the ordinary practitioner of surgery, and its structure, as we learn from Guy de Chauliac,² was not usually treated in the general course of anatomy. The custom was rather to refer the student to special works such as those of Jesu Aly or of Alcoatim.

Manfredi's description of the anatomy of the eye is that generally accepted at the end of the fifteenth and the beginning of the sixteenth centuries, and is unusually clear for its date. It represents a considerable advance on such writers as Henri de Mondeville (1260-1320)³ or the pseudo Richardus Anglicus, and is far superior to the descriptions of the eye dating from the fourteenth and fifteenth centuries recently brought to light

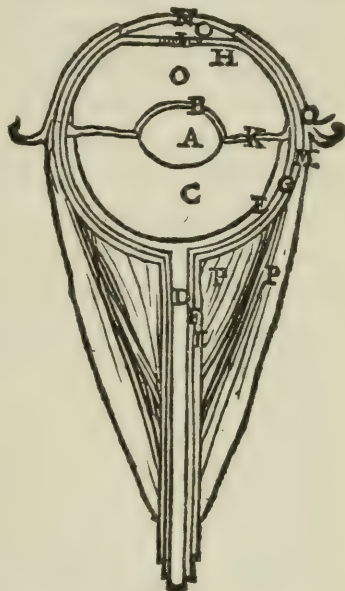


FIG. 20.

THE ANATOMY OF THE EYE

From Vesalius, *De humani corporis fabrica*, Basel, 1543, p. 643. A, Crystalline humour; o, Albugineous humour; c, Vitreous humour; n, Cornea; q, Conjunctiva; m, Sclerotica; g, Secundina; h, Uvea; k, Arachnoidea; e, Retina.

¹ The so-called *Anatomia Richardi Anglici*, which has been printed by Robert Ritter von Töply (Vienna, 1902), is really the same as the pseudo-Galenic *Anatomia vivorum*, to which Richard's name was not attached until the fourteenth century. See Christoph Ferckel, *Archiv für die Gesch. der Naturwissenschaften und der Technik*, vol. vi, p. 78, Leipzig, 1912, and K. Sudhoff, *Archiv für Gesch. der Medizin*, vol. viii, p. 71, Leipzig, 1915.

² E. Nicaise, *La Grande Chirurgie de Guy de Chauliac*, p. 45, Paris, 1890.

³ J. Pagel, *Die Anatomie des Heinrich von Mondeville*, Berlin, 1889, p. 37.

by Sudhoff.¹ We reproduce as illustrating Manfredi a diagram taken from the *Margarita philosophica* of Gregorius Reisch (died 1525). This represents the earliest printed figure of any value of the anatomy of the eye (Fig. 19).² We give for comparison the figure from a thirteenth-century MS. of Roger Bacon (Plate XXXVIII *a*), representing the rival tradition of Avicenna and Alhazen that influenced Leonardo da Vinci and other contemporaries of Manfredi. These figures may be compared with that of Vesalius (1543, Fig. 20), whose description of the eye is less free from traditional bias than are most parts of his epoch-making work.

In reading any early description of the eye, it is to be remembered that until the nineteenth century the 'emanation theory' prevailed. Light was regarded as of the nature of a stream of particles emitted from the object seen, and the act of vision was considered as a collision of this emanation with an emission of something from the eye itself, called in mediaeval writings the 'visual spirit'.

(c) THE HEART

Tractate ii, Chapter 3

(folio 19 verso) Then you will see in the midst of the lung the heart, covered by its membranes. [It is thus situated] that the air attracted by this lung should cool it, and that thus the heat and spirit of the heart be tempered. This member is the most important of the four [principal members], because it is the first to live and the last to die. It is of medium size compared with the other members of man, but compared with the hearts of other animals it is very large, because man, in a quantitative and not an intensive sense, has more natural heat than other animals. It is pyramidal, that is in the form of a flame; because it is of excellent warmth,

¹ For the whole question of early figures of the eye consult K. Sudhoff, 'Augen-anatomiebilder im 15. und 16. Jahrhundert' in his *Illustrationen medizinischer Handschriften und Frühdrucke*, Leipzig, 1907; and the same writer's recent article on 'Augendurchschnittsbilder aus Abendland und Morgenland' in *Archiv für Gesch. der Medizin*, vol. viii, p. 1, Leipzig, 1915.

² Our figure from the *Margarita philosophiae* has been taken from the 1503 edition, the earliest to which we have had access. A figure in the *Philosophiae naturalis compendium* of K. Peyligk, dated Leipzig, 1489, is so inferior as to be negligible in this connexion.

therefore it is necessary that it should be of a shape resembling a flame. Its figure is also called 'pine-shaped', because it is wide below and narrow above, being thus formed that distinction could better be made between its cavities or ventricles; moreover, had it been made of a shape all uniform as is the lower part, it would be too heavy and ponderous.

This member is situated in the middle of the entire body, measured in every direction; that is, in the middle between the upper and lower parts: in the middle also between front and back and right and left, like a king standing in the midst of his kingdom, and this was done that it might give the strength of life equally to all the members; and although the heart as regards its foundation and base be in the middle, yet its point declines to the left below the left breast, so that it warms the left side as the liver warms the right.

This member is sustained and strengthened by a certain cartilaginous bone. For since it is continually moving, it needs some point of purchase to support it in its movements. Moreover, it has a certain fatty layer on the outside which prevents the heart from drying and keeps it moist: and there are certain veins and arteries dispersed through its substance: and it is formed also of a kind of hard flesh so that it may sustain many and forceful movements; also it is formed of longitudinal, latitudinal, and transverse fibres, so that it may have the power to attract, retain, and expel.

This member has three ventricles or chambers, like the brain. One ventricle is on the right side, the second on the left, and the third in between. The right ventricle towards the liver has two orifices. One is towards the liver and is very large. Into this there enters a vein called *vena chilis*, which arises in the convexity of the liver and brings the blood from the liver to the heart. In that right ventricle the blood is purified, and then sent by the heart to all the other members.

Now since the heart attracts by this orifice of the *vena chilis* more than it expels, therefore nature ordains that in the moment of contraction when the blood is expelled this orifice closes, and when the heart dilates it opens.

Moreover there are three little valves (*hostiolitti*) or doors opening from without inward, and these valves are not very depressed; so that by this same orifice only part of the purified

blood is expelled to the other members, because part goes to the lungs and the remainder forms the vital spirit; therefore nature ordains that these valves do not entirely close. From the *vena chilis*, before it enters the cavity of the heart, there arises another vein, which surrounds the root of the heart; and from it are given off branches which disperse themselves through the substance of the heart, and from the blood of that vein the heart nourishes itself.

The right ventricle towards the lung has another orifice into which opens the *arterial vein*, bringing the blood from the heart to nourish the lung: in this orifice also are three valves (*hostioli*) opening from within outward and closing from without inward, in the opposite way to the valves of the other orifice; and this is so that they should entirely close. Hence by this orifice the heart during the period of contraction can expel, and yet during the period of its dilatation cannot attract anything through it as was done in the first orifice.

The left ventricle of the heart has its sides denser and thicker than the sides or walls of the right ventricle; and this for three reasons: Firstly, because in the right ventricle is contained the blood, which is heavy, while in the left ventricle there is spirit, which is very light; therefore in order that the heart should not be heavier and more ponderous on one side than on the other, it was necessary to compensate in this manner, that is, that the left ventricle should be thicker in its walls than the right. In the second place, the spirit being more subtil and more volatile (*resolubile*) than blood, it needs a stronger habitation and better supports. Thirdly, the left ventricle is much warmer than the right, because in it is generated the spirit from the blood, by a great heat which makes that blood more subtil; and heat is better preserved in a substance that is dense and thick.

In the cavity of this ventricle near its root are two orifices: one is the orifice of an artery called *artharia adorti* [= aorta], because it has immediate origin in the heart and because it is the source of all the others: by this artery the heart sends the generated spirit to all the members; and the very subtil blood is mixed with the spirit when the heart contracts. For which reason there are at the entrance of this orifice three valves, which close entirely from the outside inwards; and they open from the inside outwards, and this orifice is very deep.

The other orifice is that of the *venal artery* which conveys the air from the lung to cool the heart and transports warm vapours from the heart to the lung as has been said above ; and in this orifice are two valves which do not entirely close : and they are well raised so that they can better apply themselves to the sides [edges] of the heart when it sends out the spirit : these are marvellous works of nature, as is also the central ventricle of the heart, for this ventricle has not one cavity but many ; these are small but wide, and more numerous on the right than on the left ; and nature contrived thus, so that the blood which goes from the right ventricle to the left to be converted continually into spirit becomes thin in these cavities.

And by this thou canst see that four things have birth in the heart. The first is the artery called *adorti*, the second is the *vena chilis*, the third is the *arterial vein*, and the fourth the *venal artery*.

Also thou wilt see in the heart certain membranous parts like *auricles*, or rather like small ears, able to dilate or contract ; these are contrived by nature in order that when overmuch blood or spirit is generated the heart can dilate so as to contain it ; and also that the heart may contract when there is no such abundance.

And it is here that Galen asks, Why did not nature make the heart so large that it could contain every increase of blood or spirit without the addition of these membranes ? Galen replies that this was first because the heart would have been too large and therefore too heavy ; secondly, because as it is not always generating a great quantity of blood and spirit, if the heart had been too large, its cavity would usually have been empty : but these auricles dilate with the accumulation of blood or spirit, and contract with its decrease.

The heart is surrounded by a firm and nervous membrane, like a little house in which it is placed as in a tabernacle to defend it from accidents. This capsule is very dilated, that the heart in its dilations and movement may not be impeded thereby, and therefore nature made this capsule so that it should contain a certain dewy moisture with which the heart is bathed and moistened so that in its continual movement it should not become dry. For when this water be dried up, then the heart itself is desiccated, and emaciates and dries up all the body.

The description of the heart follows Mondino closely. Occasionally a phrase or two is reminiscent of Mondeville. The trite conception of the heart as a king in its necessarily central position was very frequently repeated by writers in the Middle Ages. To Harvey, who had a certain mediaeval element in his mentality, it seems to have appealed, and he used it in his *Prelectiones Anatomiae*,¹ and chose it to introduce his great work on the circulation of the blood.² The heart was similarly described as 'flame-shaped', because it was regarded as the source of animal heat. The idea that it is the first to live and the last to die comes from Aristotle.³ The *bone* in the heart also comes from Aristotle.⁴ The idea was quite familiar to mediaeval anatomists, who frequently endeavoured to identify the *bone* with the firm tissue around the orifices of the aorta and pulmonary artery. The reader may be reminded that a true 'os cordis' is in fact to be found in some mammalia.

Mondino, followed by Manfredi, describes the action of the heart and blood-vessels mainly according to the views of Galen, but without any very clear or connected statement. The 'third ventricle' especially has its origin in a misunderstanding.

This mythical structure is an attempt to combine the views of Aristotle and of Galen. Aristotle, who probably never dissected a human body, derived his anatomical conceptions largely from cold-blooded animals, in some of which the heart is provided with three cavities. He considered that the heart had three chambers, the largest being on the right, the smallest on the left, and one of intermediate size between the two. As far as they can be identified, the largest was the right ventricle plus the right auricle, the smallest or left chamber was the left auricle, while the intermediate cavity appears to have been the left ventricle.⁵

¹ W. Harvey, *Prelectiones anatomiae universalis*, reproduced in facsimile from the author's MS. notes, London, 1886, folio 72 recto.

² W. Harvey, *Exercitatio anatomica de motu cordis et sanguinis*, Frankfort, 1628. The opening passage of the dedication to Charles I may be translated as follows: 'Most serene king, the heart of animals is the basis of their life, the sun of their microcosm, that from which all strength proceeds. The king is in like manner the basis of his kingdom, the sun of his world, the heart of the commonwealth, whence all power derives, all grace appears.'

³ *Historia animalium*, vi. 3.

⁴ *Historia animalium*, ii. 11; *De Partibus animalium*, iii. 4.

⁵ *Historia animalium*, i. 14 and iii. 3; *De Partibus animalium*, iii. 4. The question of the identity of these chambers is a difficult one. We have followed T. E. Lones, *Aristotle's Researches in Natural Science*, London, 1912, p. 137, where the conflicting views are summarized.

Galen's description differed altogether from that of Aristotle. He tells us expressly and somewhat contemptuously that 'it is no marvel if Aristotle erred in many anatomical matters, a man who thought forsooth that the heart in the larger animals had three chambers'.¹ Galen always describes the heart as having but two chambers, the right and left ventricles, a wholly subordinate part being assigned to the auricles. These latter were regarded as safety-valves, expanding to hold superfluous blood when the chambers of the heart to which they correspond become overfilled.

No third ventricle is described by Rhazes or Haly Abbas,² but Avicenna, in his *Canon*, makes an effort to combine the views of Aristotle and Galen. Speaking of the anatomy of the heart (lib. iii, fen. xi, chap. 1) he describes the ventricular portion as follows: 'In the heart are three cavities, two large, and a third as it were central in position. So that the heart has [a] a receptacle [the right ventricle] for the nutriment with which it nourishes itself—this nutriment is thick and firm like the substance of the heart; [b] a place where the pneuma is formed [the left ventricle], being engendered of the subtil blood; and [c], thirdly, a canal between the two.'³ A somewhat similar account is given in Constantine's translation of Isaac.⁴ The idea soon crept into European medicine, for in a Pisan MS. dating from the first half of the thirteenth century⁵ a crude figure of a three-chambered heart is to be found (Fig. 21).

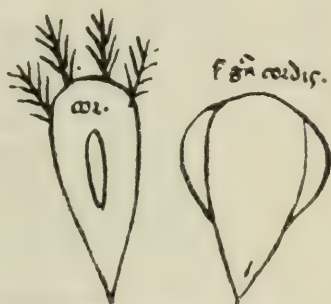


FIG. 21. THE HEART
From the Roncioni MS. (Pisa 99)
after Sudhoff.

¹ Galen, *Περὶ ἀνατομικῶν ἐγχειρήσεων*, Book 7 (157); καὶ θαυμαστὸν οὐδέν, ἄλλα τε πολλὰ κατὰ τὰς ἀνατομὰς Ἀριστοτέλη διαμαρτεῖν, καὶ ἡγείσθαι τρεῖς ἔχειν κοιλίας ἐπὶ τῶν μεγάλων ζώων τὴν καρδίαν, Kühn, ii. 62.

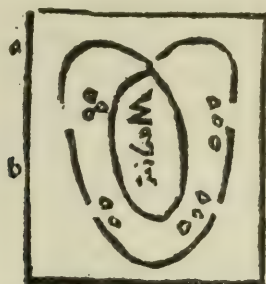
² Haly Abbas expressly denies its existence, chap. 21.

³ P. Koning, *Trois traités d'anatomie arabes*, Leyden, 1903, 687, renders the passage as follows: 'Dans le cœur il y a trois cavités, deux grandes et une autre qui se trouve pour ainsi dire au milieu, afin que le cœur ait un dépôt pour la nourriture avec laquelle il se nourrit, nourriture épaisse et forte, semblable à la substance du cœur, ensuite un endroit où se forme un pneuma qui y est engendré d'un sang subtil et enfin un canal entre ces deux.'

⁴ *Pantechni. Theorice*, lib. iii, cap. 22. Here, however, only two *concauitates* are described and between them a *foramen*: *quod a quibusdam vocatur tertia concauitas: sed non est ita.*

⁵ The MS. Roncioni 99, reproduced by K. Sudhoff in *Archiv für Gesch. der Med.*, vol. vii, Tafel XIV, Leipzig, 1914.

The first translator of the *Canon of Avicenna*, Gerard of Cremona, whose work appeared towards the end of the twelfth century, improved on his original. 'In it [the heart] are three ventricles; two are large, and the third as it were between, which Galen called the fovea or non-ventricular meatus, so that there may be



Argumentū rei cum interpre-
tatione Jo. Adelphi.

A ¶ Arterie adorti p̄ quā mit-
tit cor sp̄m̄ ad oīa corpis mē-
bra q̄n̄ p̄stringit. Et^o hostiola
claudunt p̄fecta clausiōe ab
extra ad intus / r̄ aperiuntur
econverso.

B ¶ Arterie venalis portātis
vapōrē a corde ad pulmonē

et attrahentis aerem a pulmone ad cor. Cuius hostiola im-
perfecte claudunt / h̄is tunicā vnicā / q̄ natura paz sollici-
ta est de eo quod per ipsum transit.

C ¶ Vene chilis / per eius onficiū irahit cor: sanguinē ab
epate / r̄ mēdat ad oīa mēbra. Claudit hora expulsioni r̄
aperit hora dilatōis. Eius hostiola aperiunt ab extra ad
intus / r̄ imperfecte clauduntur.

D ¶ Vene arterialis que portat sanguinē ad pulmonem
a corde: arterialē sc̄z. Quaz tunicaz p̄pter accessuz ei^o ad
membz p̄tini motus. Et q̄ portat sanguinē colericū val-
de subtilē: eius hostiola aperiunt ab intus ad extra / r̄ clau-
dunt ecōverso perfecte. Per hoc onficiū cor im̄ a se expellit
hora p̄strictōis / r̄ nihil retinet hora dilatōis. Horz duoz
arterie venalis r̄ vene arterialis / p̄tranū h̄z Galie. viij. de
utilitate p̄ticulariū. ix. ca. Et de iuvamētis mēbroz. vij. c.
v̄i de Venulis li. xxx. cap. primo.

FIG. 22. From Johannes Adelphus, *Mundini de omnibus humani corporis interioribus membris Anathomia*, Strassburg, 1513. The diagram shows the two lateral ventricles and the 'central' ventricle. By a printer's error the letters *c* and *d* are transposed. The *arteria adorti* is the aorta, the *arteria venalis* the pulmonary vein, the *vena chilis* the vena cava, and the *vena arterialis* the pulmonary artery. The auricles are ignored, as is frequently the case in works of the period, and the pulmonary veins are represented as opening directly into the ventricles.

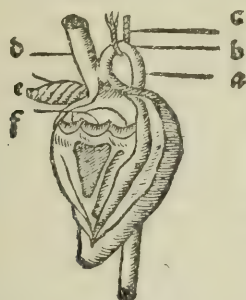
a receptaculum for the thick and strong nourishment, like to the substance of the heart, with which it is nourished, and also a storehouse for the pneuma (spiritus) generated in it from the subtil blood. And between the two are channels or meatuses.'¹ Henri

¹ The passage in the *Editio princeps* of Gerard of Cremona's translation runs as follows (folio 96 recto): 'Et in ipso sunt tres ventres, scilicet duo ventres magni et venter quasi medius quem Galienus nominavit foveam aut meatum

de Mondeville (died about 1320), by going direct to Galen, avoided some of the errors of Avicenna, with whom, however, he still describes three ventricles.¹ Mondino does little but copy the Arabian, whom Manfredi also follows.

We may terminate our description of the mythical third ventricle by quoting from Bartholomew the Englishman. His encyclopaedia written about 1260 was translated into English in 1397, and printed by Thomas Berthelet² in the 27th year of the reign of Henry VIII (1535), when Bartholomew's work was still extremely popular. Berthelet's rendering runs as follows :

' And the hert hath ij holownesses, one in the left syde, that cometh sharpe : and one in the ryght side, that is within : And



A. b. bedeut den ganzen stamm der grossen hertz aderen / so sich herab durch alle glieder erstreckt. c. der obern hauptadern theyl. d. ist die groß lufftröhre / Trachen genant. e. bedeut das ohrlin des hertzen. f. zeiget das ort des herage blüts / so da ist ein befreffungig anderer lebhaftiger glieder.

FIG. 23. From Hans von Gersdorff, *Feldt und Statbüch bewerter Wundartznei*, Frankfurt, 1556. The trachea (*d*) is represented as opening directly into the heart.

these two holownesses ben called the wombes of the hart. And betwene these two wombes is one hole, that some men call a veyne, other an holowe way. And this hole is brode afore the ryghte syde, and streyte afore the left syde. And that is nedefulle to make the bloode subtyll, that commeth from the ryght wombe to the lefte, and so the spirite of lyfe may be bredde the easelyer in the lefte wombe.'

In order to understand why all these authors invoked the existence of the third ventricle, regarded by some of them as a passage between the other two, we must turn to the physiological beliefs of the age. It must be recalled that before the demonstration of the circulatory movement of the blood a

non ventrem, ut sit ei receptaculum nutrimenti quo nutriatur spissum forte simile substantiae ipsius & minera spiritus generati in ipso a sanguine subtili. Et inter ambos sunt viae ut meatus.'

¹ J. L. Pagel, *Die Chirurgie des Heinrich von Mondeville*, Berlin, 1892, p. 45.

² Bartholomaeus Anglicus, *De Proprietatibus Rerum*, London, 1535. Our quotation is from p. liiii.

certain amount of communication was believed to exist between right and left ventricles. The complicated nature of the ventricular cavities and the intricacy of the columnae carnae promoted the idea of the presence of minute passages in the interventricular septum. Even so astute an observer as Leonardo da Vinci considered that 'the ventricles are separated by a porous wall, through which the blood of the right ventricle penetrates into the left ventricle, and when the right ventricle shuts, the left opens and draws in the blood which the right one gives forth' (Plate xxxviii b).¹

Although the third ventricle is described in all the twenty-five editions of Mondino, many of which are illustrated, they present no drawing of it except the wretched little diagram of J. A. Muelich (Johannes Adelphus) in 1513, which we here reproduce (Fig. 22). The confusion, however, to which the idea of a third ventricle gave rise influenced anatomy almost as late as the seventeenth century, and is illustrated in the anatomical figures of a late edition of Hans von Gersdorff (1556),² where the trachea is actually shown opening into the left ventricle (Fig. 23). It was Vesalius who took the first great step towards the discovery of the circulation of the blood, by firmly maintaining that the interventricular septum was solid and contained neither passages nor intermediate ventricle.³

VI. ITALIAN TEXT

MS. CANONICI ITAL. 237

*Hieronimi manfredi ad Magnificum & potentem dominum ac militem
Iohannem Bentiuolum insequens opus de corporis humani
anotomia exordium.*

[folio 1 verso] Opportet de sapientia admirari creatoris ut xv^o de utilitate particularum scribitur a Galieno. Cum enim membrorum nostri corporis admirabilem Galienus aspiceret Armoniam predictum sermonem explicauit : ut nos ad dei sublimis et gloriosi admiranda opera commoueret : Quamuis nostra cognitio a dei comprahensione deficiat : unde et Seneca XL^a epistola

¹ Leonardo da Vinci, *Quaderni d'anatomia . . . Pubblicati da O. C. L. Vangenstein, A. Fonahn, H. Hopstock, Christiania, 1911.*

² Hans von Gersdorff, *Feldt und Statbüch bewerter Wundartznei*, edition Frankfurt, 1556.

³ Ancient views on the cardiac system, including those of Mondino, are admirably reviewed by J. C. Dalton in his *Doctrines of the Circulation*, Philadelphia, 1884.

ad Lucillum ait quid deus sit incertum est habitat in nobis : Sed deum mouemur inuocare eius sapientiam mirabiliter contemplantes. Quanta enim fuerit summi opificis in producendo res sapientia quanta eius sollicitudo et prudentia opera profecto nature declarant : unde et psalmista mirabilia sunt opera tua deus, et alibi celi enarrant gloriam dei et opera manuum eius annuntiat firmamentum. Quis enim talia et tanta inspiciens creatorem suum abneget et eius potentiam ? Inscipiens quidem erit hic iuxta illud psalmiste dixit inscipiens in corde suo non est deus. Sublimis autem dei multiplia et diuersa fuere opera. Creauit enim duplita entium genera scilicet corruptibilia et incorruptibilia ; et in utrisque suam admirabilem sapientiam, suamque [folio 2 recto] infinitam potentiam ostendit. Totam enim entis latitudinem nihil prorsus de spetiebus, quas ab aeterno in mente sua retinuit obmittens perfulciuit, et eas quas ab aeterno in sua habebat essentia ad aliud esse procreauit, ut in indiuiduis esse haberent : quae in suae maiestatis lumine existebant : et uniuscuiusque spetiei modo perfecit ac uarietates per esse quod in singularibus habent (natura mediante & cum lege) imposuit. Admirantur angelorum caetus obstupent hominum intellectus tantae maiestatis opera mirabilia : ut hoc summo bono : hoc perfectissimo ente nihil melius excogitari possit. O admirabilem maiestatem, O deitatem incompraehensibilem, O inefabilem potentiam : Quis te negliget ? Quis te non insequetur ? Quis in operibus tuis non delectabitur ?

Omnis igitur qui in operum dei gloriosi intuitu delectatur, hic prudens et non inscipiens est : hic dignus homo : hic intellectu non caret. Cum igitur tua illustris Dominatio Iohannes bentiuole magnanimis praesenti anno ex sui qua solet humanitate ad cuiusdam hominis defuncti anothomiam uno semel uidere non fuerit dedignata ob sui intellectus dignitatem qui semper alta intelligere concupiscit, cumque tu opera tam naturae miranda in anothomizato incaepisti uidere corpore tunc haec intelligendi creuit animus, tua digna [folio 2 verso] creuit uoluntas : Et me hyeronimum Manfredum ad hoc opus de anothomia intitulum materno sermone tuo dignissimo nomini inscribere concitasti : (ut omnino sicut debeor) rem gratam tuae faciam dominationi : In hoc enim tui agnoui dignitatem intellectus, tui ingenii solertiam quod in rebus naturae mirandis tuum peruoluas intellectum. Hoc enim opusculum quantum melius potui ex uariis antiquorum uoluminibus exserpsi ac id abreuiaui : nec eundem forte tenui ordinem ut illi : et ipsum materno composui sermone ut opus hoc delectabilis tuae sit magnificentie.

Accipe igitur magnifice et potens domine hoc opus de corporis humani anothomia tuo dignissimo nomini intitulum, ea benignitate et humanitate, qua soles : et animo illari ac gratioso id accepta : qui satis tibi erit delectabile et perplacebit quia dignum est opus : Vale miles magnanimis, et solito ama.

Finis prohemii.

[Here a folio is missing.]

[folio 3 recto] a li nerui lequale hano origine da le extrema di muscoli : Unde e da sapere che li muscoli sono compositi de nerui, corde, e ligamenti e carne facti da la natura a dare el moto uoluntario, Impero da le soe extrimita escono queste tale corde e uadono a membri che se debano mouere : e quando se retraheno li dicti muscoli consequenter se se retraheno le lor corde : & finaliter i membri : et similiter quando se dilatano i muscoli se dilatano etiam le corde & consequenter i membri.

Li ligamenti sono etiam simili a nerui facti a ligare le iuncture de le osse e non li dette la natura sentimento como fece a li nerui & a le corde acio che per el molto mouimento e fricatione de le iuncture non doleseno.

Le Artarie sono de substantia neruosa & ligamentale in longo extense e concaue : ne le quale se contene el sangue sutilissimo & depurato et el spirito uitale el quale e mandato dal core a dare uita a tuti i membri : et hano origine da esso core : & impero hebene doe tuniche acio chel sangue sutile & el spirito uitale non usisseno fuora.

Le vene sono simile a lartarie ma sono quiete e non se moueno, ma hano origine dal figato et in esse se contene el sangue grosso cum li altri humuri che non e cusi depurato ne [folio 3 verso] cusi sutile como e el sangue de le artarie : impero non li fece senon una tunicha : per che quello sangue non era cosi sutile chel potesse penetrare fuora ne anche non bisognandose mouere non era suspitione de rompersi como ne le artarie che era necessario a mouerse per refrigerare el core atrahendo laiere frigido & expellendo fuora li fumi caldi da esso.

Li panniculi sono composti e texuti de fili neruosi sutilissimi che non se posseno uedere e sono questi paniculi spissi e sutili e sono de molte manerie : Alcuni forno facti a continere e coprire a Alcuni membri e custodirli ne la sua figura e substantia como sono li paniculi che copreno el cerebro e molti altri di li quali poi diremo : Alcuni altri panniculi sono facti a suspendere uno membro a laltro como li rognoni sono aligati a laschina mediante uno certo paniculo : Alcuni altri paniculi sono facti acio che alcuni membri che non hano sentimento receuano qualche sentimento per el paniculo : nel quale sono inuolti como sono el pulmone el figato la milza & i rognoni li quali sono priuati de sentimento impero la natura aciascuno di loro li fece uno paniculo doue fusseno inuolti per la casone dicta.

Da poi tuti questi membra hauendo la natura ordito el corpo de l homo de [folio 4 recto] li predicti bisogno reimpire le uacuita e reimpille de carne : Fece aduncha la natura la carne per reimpire le uacuita che rimangono da lorditura de nerui uene & altri membri dicti.

Praeterea e da sapere che la natura ha dato aciascuno di li predicti membri quatro uirtu. Una e uirtu atratiua per laquale ha ad atrahere el nutrimento suo a se del quale el membro se ha a nutrire : La seconda uirtu e digestiua per laquale el nutrimento atrato se digerisse & conuertese ne la sustantia del membro : La terza uirtu si e retentiua per laquale el nutrimento atrato se retiene debito tempo acio che la uirtu digestiua possa perficere la sua operatione circha quello : La quarta uirtu e expulsiua laquale ha expellere le superfluita che se generano dal nutrimento ne la digestion.

Anche e da sapere che la natura nel corpo de lhuomo ha facto quatro membri principali como quatro signori et aciascuno di loro li ha dato una casa o uero uno palazzo a sua custodia doue habite cum certe camare o uero stantie che hano aseruirli al suo bisogno : El primo membro principale e signore e el cerebro al quale li fece la natura el capo cum le sue circumstantie per suo habitaculo e dette a questo membro che lui fusse principio e radice de tuto el sentimento e moto de tuto el [folio 4 verso] corpo : dal quale tuti li altri membri receuano el sentire : e el mouere, & a questo membri li dette etiam cinque uirtu cognoscitiue exteriore cio e li cinque sentimenti e cinque altre uirtu cognoscitiue interiore che deseruano a lo intellecto.

El secondo membro principale e signore si e el Core alquale la natura ha dato la sua casa cio e el pecto cum le sue adiacentie : et a questo membro li ha dato la uirtu de la uita dal quale proceda la uita in tuti li altri membri como da uno primo principio.

El terzo membro principale e signore e el Figato alquale dette la natura per suo domicilio el uentre inferiore cum li altri membri circumstanti che sono necessarii a la sua operatione e dette a questo membro la uirtu nutritiua chel fusse principio e radice del nutrire de tuti li membri.

El quarto membro principale fu li testicoli e la sua casa e la bursa laquale li contene et aquilli deserueno piu altri membri como poi se uedera et a questi testicoli ha dato la natura la uirtu generatiua cio e de generare el sperma o uero seme el quale habia una uirtu generatiua che possa produrre una cosa simile a colui dal quale se decide tale sperma : et questo fu facto per conseruare lhuomo in spetie non se possendo conseruare in indiuiduo.

Ultra questi quatro membri principali e suoi domicilii [folio 5 recto] ha facto la natura alcuni altri membri cio e el collo cum la gola che fusse uia e transito dal primo membro principale cio e cerebro ali altri membri principali et etiam a tute laltre parte & per altre utilita quale noi da poi diremo.

Item ha facto la natura le braza e le mane che hauesseno a pigliare el cibo e mandarlo al luoco conueniente et etiam per che lhuomo solo uiue per arte lequale non se possono perficere senza le braza e mano.

Item fece le cosse, gambe e piedi acio se potesse mouere da luocho a luocho secondo li soi bisogni.

Noi aduncha ponereмо la Anothomia de tuti li membri e parte dicte : Comenciando per ordine dal cerebro e da la sua casa et consequenter descendendo per insino apiedi.

Capitulum secundum tractatus primi de anothomia capitis et omnium contentorum in eo.

Fece la natura el capo ossuoso per magiore tutela del cerebro : el quale essendo immobile non li bisogno hauere muscoli : Et per che el cerebro ne lhuomo e magiore che ne li altri animali secondo la sua grandeza impero bisogno chel capo de lhuomo fusse etiamdio grande per rispetto de li altri animali : Et etiam bisogno li meati del capo ne lhuomo essere piu distincti essendo piu dedito al cognoscere.

La figura [folio 5 verso] del capo naturale e rotonda compressa da dui canti como sel fusse una cera rotonda compressa cum le mano da la parte drita e da la stancha faria doe eminentie una dinanzi e laltra de drieto e la parte drita e stancha rimaneriano piane : Bisogno fusse rotondo acio fusse piu capace et etiam che fusse piu sicuro e risguardato da nocumenti exteriori a li quali e molto exposito : Bisogno etiam essere facto cum quelle eminentie acio che li meati del cerebro hauesseno migliore distinctione et acio che li cinque sentimenti exteriori hauesseno origine da la eminentia anteriore.

Diece sono le parte del capo : La prima e li capilli quasi capitis pili facti da la natura a magiore tutela del capo da le cose exteriori et etiam per bellezza : La seconda parte del capo e la cute la quale bisogno essere molto grossa acio che li capilli fusseno ben fermi hauendo le radice sue molte grosse e longhe et etiam che fusse migliore scuto e cooperimento de losso et del cerebro non li essendo parte muscolose : La terza parte si e la carne laquale solo e ne la fronte e ne le tempie e circha le masselle e non in le altre parte : La quarta parte e uno panniculo exteriori chiamato almochatim elquale appare in continenti como e liuata su la cute e copre tuto losso del craneo de fuora : Et fece la natura questo panniculo [folio 6 recto] acio che lacute che e molle non tochasse incontinenti losso che e duro : Et etiam acio che losso del capo hauesse sentimento per questo panniculo : Et tertio anche acio che el paniculo interiore del capo chiamato Duramater mediante questo panniculo stesse suspeso a losso del craneo cum certi nerui e ligamenti che escono per le comissure del dicto osso et hano origine dal dicto panniculo interiore & uscendo fuora de losso texono o uero componeno quello panniculo exteriori dicto Almochatim : La quinta parte e el craneo cioe osso facto

como uno capello nela concauita del quale glie locato el cerebro : & in questo craneo furno quatro ossa cusite insieme e la natura non fece questo osso uno ma de piu pezzi acio che achadando nocumento in una parte non comunicasse a laltre parte : Et etiam acio che per quelle commissure o uero cusiture potesseno meglio exhalare fuora le fumusitate dal cerebro : Et tertio acio che bisognando la uirtu de le medicine applicate potesseno meglio penetrare ale parte dentro quisti aduncha quatro pezzi de osso furno da la natura cusiti et insieme ionti in modo de denti acio fusse piu fermi e forti et non furno facti in modo che se potesseno uincare como fano le iunture per che non seriano state cusi forte : et etiam [folio 6 verso] per che non bisognaua a losso del capo mouerse : Et queste commissure sono cinque cio e tre uere e doe mendose : Le commissure uere sono quelle che passano tuto losso et le mendose non passano : De le uere commissure una si e ne la parte anteriore chiamata coronale et e facta a modo de uno C e protende da la parte drita a la stancha del capo et ha li branchi uerso la fronte. La secunda commissura uera si protende per la longheza del capo comencianda da la commissura coronale ala parte posteriore como una friza o uero sagitta che uene da larcho, impero e chiamata sagittale —C. La terza commissura e ne la parte posteriore chiamata laudale facta a modo de uno A, per abacho chiamato dal greco lauda : e la commissura sagittale protende da la coronale a la laudale } —C.

Le commissure mendose sono due da ciascaduno lato una cio e dal drito e dal stanco e sono dictae corticale per che non passano.

Et se noi consideremo per queste cinque commissure hauemo quatro ossi cusiti insieme : Uno si e losso de la fronte che comenza dala commissura coronale e termina uerso la parte inferiore a una altra commissura la quale comenza da uno brancho de la commissura coronale e procede a presso le ciglie de li ochii a laltro brancho D. Laltro osso si e de drieto el [folio 7 recto] quale se termina a la commissura laudale e dui altri ossi da le tempie che se terminano da le commissure mendose le quale comenzano da la commissura laudale a la commissura coronale.

La sexta parte sono doi paniculi uno chiamato Dura mater el quale e in continenti de poi el craneo : e laltro se chiama pia mater el quale incontinente copre el cerebro e questo fece la natura hauendo grande solitudin de questo membro acio che in continenti non fusse tocho da losso ma processe per piu mezi che uno fusse piu duro che laltro : Et anche fece dui panniculi acio che se la cadesse nocumento in uno de loro non comunicasse al cerebro in continente. Ne la pia matre sono texute certe uene per le quale se nutrisse el cerebro e si lo copre per tuto excepto la parte posteriore per che essendo quella parte sicca non bisogno di questo paniculo como la parte anteriore e meza. Questi dui panniculi in piu luochi penetrano la sustantia del cerebro et se lo diuide in parte drita e parte sinistra et in parte anteriore & parte posteriore : et per queste tale diuisione furno fabbricate nel capo diuerse celule o uero camerette ne le quale produce lanima diuerse operatione per che bisognaua che queste tale parte fuseno de diuerse complexione.

E leuati adoncha questi dui panniculi apparera La [folio 7 verso] Septima parte del capo : et e esso cerebro facta da la natura acio che el spirito uitale mandato dal core calidissimo sia contemperato da la frigidita de esso cerebro : et iue douenti spirito animale elquale e principio de le operatione cognoscitiue & motiue : e questo cerebro e una sustantia medulare biancha molle e uiscosa a cio che da essa hauesseno origine li nerui : ma la parte dinanci fu generata piu humida e molle & mancho frigida che la parte posteriore per che da la parte anteriore hano origine li sentimenti li quali sono molli & humidi ma da la parte posteriore hano origine li nerui motiui li quali

bisognano essere piu sicci e forti : Questo cerebro aduncha se diuide in tri uentriculi ouero tre parte : El primo uentriculo o parte anteriore e diuisa in doe, cio e dextra e sinistra : et e magiore che nesuno de li altri uentriculi : et in questo primo uentriculo li pose la natura doe uirtu deseruente al cognoscere una se chiama senso comune doue se terminano li altri sensi exteriori como al suo centro et deferiscono le imagine o uero spetie de le cose sensiue a quello luocho acio che quella uirtu cognosca e distingua tra una cosa sensibile e laltra et etiam cognosca le operatione di li sentimenti particolari lequale doe cose non puo fare nesuno de quilli.

Laltra uirtu de questo primo uentriculo se [folio 8 recto] chiama fantasia et appresso alcuni se chiama imaginatiua laquale ha a retinere et conseruare le spetie de le cose sensibile ne la absentia de le cose sensibile. Quando tu harai ueduto el uentriculo primo tu uederai tre cose inanzi che uegni al uentriculo secondo. La prima si e doe anche cio e una cosa facta de la sustantia del cerebro in modo de doe anche che sono fundamento del uentriculo anteriore cusi da la dextra como da la sinistra parte : et dal lato di ciascuna ancha glie una altra cosa facta a modo de uno uerme subterraneo rosa se sanguinea ligata de certi ligamenti e neruitti el quale uerme quando se alonga chiude quelle anche et consequenter chiude la uia tra el primo uentriculo et el secondo et questo fece la natura acio che lhuomo quando uole posse cessare da le cogitatione e dal considerare et similiter quando uole considerare e pensare questo uerme se contrahe et contrahendosi apre quelle anche et consequenter apre la uia che e tra uno uentriculo e laltro : La terza cosa che tu uederai un poco piu de sotta e una lacuna cio e una certa conchautia rotonda che tra allongo nel mezo de laquale glie uno bucho che ua gioso al palato et a questo bucho li occorre una uia drita laquale descende dal uentriculo di mezo al colatorio e questa lacuna ha circumquaue eminentie grande rotonde facte a sustentare [folio 8 verso] le uene et artharie che ascendeno a dicti uentriculi : e quello bucho e lato di sopra e stretto in fonde e per questa lacuna el primo e secondo uentriculo purgano le sue superfluitade benche la parte anteriore piu se purghi per li colatorii del naso : Unde queste doe uie fece la natura ad expurgare le superfluita del cerebro.

Quando adoncha tu hauerai ueduto queste tre cose incontinente te apparera el secondo uentriculo del mezo el quale e como una uia et uno transito dal primo uentriculo al posteriore : in questo uentriculo sono doe uirtu una chiamata extimatiua laquale ha elicere cose insensate da le cose sensate. Laltra uirtu se chiama cogitatiua laquale cognosce cusi le cose sensate como le cose insensate componendo e diuidendo : e questa uirtu in mediate deserue a lo intellecto : et tute le altre uirtu dicte et anche la uirtu memoratiua se ritrouano ne li animali bruti, ma questa solo se retrououa ne lhuomo.

Dapoi te occorrera el terzo uentriculo situato ne la parte posteriore duro per che e principio de la piu parte di nerui motiui liquali bisogno essere piu forti e duri : Questo uentriculo e de figura pyramidale cio e facto in punta e la punta si e ne la parte superiore doue ha aconseruare le spetie per che meglio se riserua la cosa [folio 9 recto] in stretto luocho che in amplo : e la parte di sotto e lata per che ha a receuere le spetie e meglio se receue in luocho amplo che stretto : Due adoncha utilita se ha da questo uentriculo una che e principio de la nucha e di li nerui mottiui. Laltra si e che e camera de la uirtu memoratiua.

E per questo appare che quando e offesa la parte posteriore del capo in continenti se offende la memoria e quando se offende la parte de mezo se offende la uirtu extimatiua & cogitatiua & offesa la parte dinanzi se offende el senso comune e la fantasia et in questo modo ueneno in cognitione li medici de li luochi de le dicte uirtu.

Facto questo tu leuarai el cerebro ligieramente chel non si rompa alcuno neruo e comezarai da la parte di nanzi & incontinenti te apparerano doe carne piccole in modo de doi capi de mamille simile ala sustantia de cerebro per che nascono da quello et sono coperte dal paniculo subtile cio e da la pia matre e queste sono lorgano de lo oderato doue e la uirtu olphatua.

Dal cerebro nascono septe para de nerui : procedi adoncha piu oltra ne la parte dinanci e uederai el primo paro de dicti nerui liquali sono grandi chiamasi nerui obtitii de li quali la origine e dal cerebro ne li uentriculi anteriori e procedeno uerso li ochii ma nanci che escano la pia matre se coniongono [folio 9 verso] et in lucho de la sua unione sono perforati : Uolse Galieno che dicti nerui solo se coniongessero o uero se unissero e non se incrutiasse ma quello neruo che uiene dala parte drita da poi la unione ritorna pure dala parte drita et similiter quello che uiene da la parte sinistra da poi la unione ritorna uerso lochio sinistro : Ma Rasis uolse el contrario benche la opinione de Galieno sia piu comune : questi nerui deserueno al uedere e fu necessario che se uniseno acio che le spetie de la cosa che se uede receuuta in doi ochii e portata per doi nerui ritorni a unita acio che una cosa non appara doe.

Dapoi li dicti nerui leua el cerebro secondo la sua medieta e uederai uno altro pare de nerui subtili et duri li quali uengono similiter a li ochii a darli el mouimento uoluntario componendo certi musculi.

Da poi tu uederai el terzo pare de nerui di quali una parte se ne ua ala faza a darli el sentire e el mouere uoluntario et anche una parte de quisti ua a dare el gusto a la lingua : Un altra parte de dicti nerui se mescola insieme cum el quarto¹ pare de nerui et descendeno insieme gioso a dare sentimento al Diafragma et al stomaco et alaltre uiscera : Una certa parte de li nerui del quarto¹ pare se ne ua a dare el sentimento al palato.

Da poi e el quinto pare de nerui se ne ua a li ossi petrosi liquali sono apresso [folio 10 recto] le orecchie e de questi nerui ne li buchi de lorechie se componeno certi panniculi liquali sono organo de lo audire.

Da poi e el sexto pare de nerui che se diuide in tre parte una parte ua ali musculi de la gola : Laltra parte ua ali musculi de le spalle la terza parte che e maggiore de le altre descende gio a lo epyglotto e nel diafragma se sparge nel pecto nel core e nel polmone a compagnandosi insieme cum li nerui del terzo pare dicti : Et anche da li nerui di questo sexto pare quali uadeno gio a lo epyglotto se generano li nerui de la uoce chiamati reuersiui dili quali piu disotto se uedera.

Dapoi e el septimo pare de nerui ha origine da la parte posteriore del cerebro e uadeno a dare el mouimento a la lingua uoluntario : De questi septe para de nerui li primi doi pari hano origine da la anteriore parte del cerebro : el terzo pare ha origine dal mezo de lanteriore e posteriore parte : li altri quatro para de nerui hano origine da la parte posteriore.

E dapoi quisti procedendo piu oltre leua tuto el cerebro & apparera la octaua parte del capo cioe doi panniculi posti sotto el cerebro li quali leuati apparerati la nona parte che e una certa rethe laquale se chiama rethe mirabile per che e contexta de una tessitura fortissima et miraculosa multiplicata de certe artharie sutilissime : lequale sono [folio 10 verso] rami de alcune artharie che ascendeno dal core chiamate artharie apoplectice : & in queste artharie di questa rethe se contiene el spirito uitale mandato dal core acio che douenti animale : et acio che questo spirito meglio se alterasse e disponesse fece la natura quelle artharie sutilissime diuise per minime

¹ Manfredi here follows Mondino, who confuses Galen's fourth pair with Galen's sixth pair of nerves.

parte acio che questo spirito fusse diuiso anche in minime parte : et pose la natura questa rethe mirabile sotto el cerebro perche bisogno hauere de molta custodia onde lo situo in luoco tutissimo et etiam acio che le humidita uaporese del cerebro che cadeno sopra questa rethe opilandola inducesse el sonno naturale.

Da poi tute queste cose uederai losso basilare che e la decima et ultima parte del capo e chiamasi basilare per che e base e fondamento de tuto el capo e fu facto duro acio che le superfluita che descendono a lui non lo putrefesse : e questo osso e diuiso in molti altri ossi como se puo uedere cociandolo. Onde se diuide ne le osse petrose e ne li ossi del naso e ne le ossi de li ochii & in doi altri ossi laterali li quali non se possono uedere se non per uia de decocione.

Capitulum tertium de anothomia oculorum et membrorum deseruientium uisui.

Le ossa del naso fono cauernose e porrose acio che le superfluita del cerebro possano meglio de[folio 11 recto]scendere e lo odore ascendere.

Dapoi scinde tuti doi li ossi de gliochii e uederai la colligantia loro cum li nerui obtitii e cum li nerui motiui : e el loco de li ochii non fu molto in profondo per che douea receuere le spetie de le cose uisibile : ne anche fu tropo eminente acio non receuesse lesione da le cose exteriore : Et essendo li ochii molli e passibili ne lhuomo fece la natura li supercillii acio fusseno custoditi da le cose che descendeno de su in gioso e fece le palpebre che fuseno custoditi da le cose che uengono da fuora dentro : e fece le eminentie de le maxille et anche el naso in mezo che da ogne lato e per ogne uerso fusseno custoditi : tanto fu la sollicitudine che hebe la natura di questo membro.

Septe sono le tuniche e tri humori di liquali e composto lochio tre tuniche anteriore se coiongono cum tre altre posteriore como se fusseno sei scutelle che cum la bocha ogne doe se coniongesseno e che doe fussene maggiore che contineseno le altre doe e poi li e la septima tunica che e maggiore de tute e contene tuto lochio : e pero se chiama coniontiua per che congiunge e circunda tuto lochio excepto el luocho de la pupilla e quello pocho de la cornea che appare e questa e la prima tunicha comenzando da le parte de fuora et e bianca.

La seconda tunicha ne la parte dinanci se si chiama cornea [folio 11 verso] per che se asomiglia al corno quanto ala substantia e quanto al colore : e fu questa tunicha trasparente acio che le spetie de le cose uisibile potesseno penetrare per essa e fu etiam sollida e grossa composita de quatro pellicule e questo fu per che e propinqua a le cose exteriore non receuesse nocumento da esse e cum questa tunicha ne la parte posteriore se conionge un altra tunica dicta scleroticha cio e dura e queste doe tuniche hano origine dal paniculo di sotto el craneo cio e da la dura matre cusi como la prima tunicha ha origine dal panniculo disopra el craneo dicto almochatim.

La quarta tunicha ne la parte dinanzi se chiama ueua a similitudine de uno grano de uua negra et in el mezo di quella glie uno buco che se chiama la pupilla : fece la natura questa tunica obscura aciochel spirito uisiuo se confortasse e che non si resoluesse dal lume exteriore : e fece quello buco in questa tunica acio che le spetie potesseno penetrare senza impedimento e fecelo stretto aciochel spirito uisiue fusse unito : Onde quando dicta pupilla o uero buco se alargha oltra el debito o per natura o per accidente se impedisse el uedere : e ne la parte de drieto se li coniongne la quinta tunica dicta secundina per che e facta a similitudine de la secundina cio

e paniculo nel quale se inuoltano li putti nel uentre [folio 12 recto] de la matre et hano origine de la pia matre.

La sexta tunicha se chiama ne la parte dinanzi aranea per che e facta in modo de una tela de ragno a la quale ne la parte posteriore se li coniongne la septima tunicha chiamata arethina per che e facta in modo de una rethe : et in mezo de la tunicha uuea et de la aranea da la parte dinanzi glie uno humore dicto albugineo facta a similitudine de uno albumo de ouo facta per humettare lochio et acio che la tunicha cornea stia suleuata impero in li homini che moreno quando questo humore se desicca cade la cornea e se si spiana et a lhora dice el uulgo che appare una tela dinanzi da gliochii et e signo infalibile de la morte : Et anche questo humore tiene la pupilla apperta impero quando se sicca se stringe la pupilla : Nel meze de le due ultime tuniche cio e aranea et arethina lequale hano origine da nerui obtitii li sono dui humuri cio e uno humore uitreo a similitudine de uno uetro liquefacto : Laltro humore e dicto cristallino a similitudine del cristallo : dicto etiam grandineo a similitudine de una grandine et e alquanto duro e rotondo cum una certa planitie ne la parte anteriore doue se receueno le spetie de le cose uisibile : e ne la parte posteriore e de figura pyramidale cio e che e facta in punta : et iue se compisse [folio 12 verso] lacto del uedere : e ne la parte posteriore e circumdato da lhumore uitreo dal quale se nutrisse : e questo humore cristallino declina piu uerso la parte anteriore e lhumore uitreo uerso la parte posteriore. Et a li ochii uengono li nerui obtitii per li quali se de portano le spetie uisibile da gliochii al senso comune et ali altri sensi interiori.

*Capitulum quartum de anothomia aurium et membrorum
deseruientium auditui.*

Expedito questo tu uederai le orecchie poste da doi lati del capo in mezo de lanteriore parte e posteriore acio che la uoce o uero sono se potesse audire da ogne canto cio e da la parte drita e stanca dinanzi e de drieto de sopra e disotto : non furno situate da la parte dinanzi per che iue li sono gliochii el gusto e lolphato : non furno poste de drieto per che seriano state tropo distante dal senso comune : furno poste sotto la tonsura di capilli per che se piu sopra fusene stato poste seriano state uelate da cepilli e da quelle cose che se portano in capo.

Furno le orecchie rotunde acio fusseno piu capace de laere sonoro : non furno cossuose acio che per qualche percussione o caso non se rompeseno : furno adoncha carthilaginose acio che fusseno piu sonore : non furno etiamdio carnose ne paniculare per che non hauerebeno seruata la figura e compositione [folio 13 recto] debita.

Hebbe uno buco ritorto e non dritto como quello de le limache acio che se facesse migliore reuerberatione de laiere sonoro in esse : et anche ne aiere disproporcionato ne sono si tropo forte senza misura peruenisse a lorgano de laudito : e questo buco e uelato de uno paniculo duro texuto de fili neruosi che hano origine dal quinto pare de nerui del cerebro et de fili ligamentali che hano origine da losso petroso al quale se termina el dicto buco : ne la concauita del quale li e el neruo auditiuo cio e nel quale se compisse laudito et e texuto in modo de uno panniculo : et e continuo a la dura matre nel quale se contiene uno certo spirito auditiuo dal principio de la generatione iue complantato : et apresso di quello li e una certa uisichetta ne laquale e posto un certo aiere connaturale el quale deserue a laudito.

*Capitulum quintum de anothomia nasi et aliorum membrorum
deseruentium olphatui.*

Le osse de le maxille comenzano da la comissura che e tra el craneo e losso basilare in luocho che e ne la fine del sopracilio e de la fronte et procede uerso la parte posteriore a presso losso petroso doue se termina lorechia e terminano ne la parte di sotto a li denti : de liquali poi uederemo la nothomia.

El naso e composito de doi ossi figurati [folio 13 verso] secondo la forma de doi trianguli che hano le ponte in su uerso el collatorio : et sono lati ne la parte de sotto. Onde el naso e piu largo di sotto che di sopra e queste ossa furno sutile acio che fusseno ligiere e non graue : ne anche furno tropo dure per che non li bisognaua in quello luocho grande forteza.

Fu etiam el naso composito de tre carthilagine cio e doe ne lextremita de doi ossi acio che le parte molle cio e la cute e li musculi immediate non fusseno tochi da le osse dure e che le nare stesseno aperte e se potesseno dilatate e constringere secondo la necessita de laiere atrato & expulso e questo non se harebe potuto fare se solo fusse stato ossuoso.

La terza carthilagine diuide el naso per mezo per el longo et e piu dura ne la parte superiore che ne la inferiore : Onde furno facti doi meati e buchi acio che uscendo le superfluita per uno laltro deseruisse a laiere atrahato et expulso : Onde essendo uno meato solo ne lEXITO de le superfluita harebbe impedito el transito de laiere : questi doe meati peruengono al collatorio cio [e] uno buco che e ne losso basilare et similiter iue sono perforati li dui panniculi che copriano el cerebro per insino a le caronchole mamillare : lequale sono ne lextremita de le due parte del uentriculo anteriore del cerebro como e stato dicto.

El naso etiam fu composito de doi musculi [folio 14 recto] piccoli acio che essendo grandi non impedissento gialtri musculi de la fazza cio e quilli che sono ne le maxille che moueno i labri : et similiter gialtri musculi.

El naso fu composito per molte rasone : prima per euentare el cerebro : Secundo ad atrahere laiere : nel quale sono le spetie de le cose odorabile : e cusi deserue a lolphato : Tertio acio che le littere prolata meglio se distinguano come el buco grande de la fistola o uero zalamella deserue ala distinctione di soni : Quarto acio che per questo meato se expurgaseno le superfluita del cerebro.

*Capitulum sextum de anothomia oris palati dentium uuulae
faucum et linguae.*

Ne la bocha sono doi labri uno disotto e laltro si e disopra composti de nerui carne cute e panniculo de una mirabile comixtione in modo che la cute e la carne e li nerui et el panniculo non se posseno seperare insieme : e questo fu facto acio che hauendo bisogno quisti labri di mouerse per ogni uerso bisogno che fusseno cusi composti per che non se posse fare in quello luocho musculi per la graueza grande che seria stata : el paniculo che copre i labri nasce da la tunicha intrinsecha del meri cio e de la uia che ua a lo stomaco : et consequenter se continua per questo modo cum la tunicha interiore del stomaco cusi como etiam dio tute le altre parte de la bocha se [folio 14 verso] continuano acio chel sentimento del stomaco se conformi al sentimento de la bocha et per questo appare che quando el de uenire uomito a qualche uno trema lo labro inferiore.

Da poi li labri sono trentadoi denti sedeci superiori et sedeci inferiori : de li inferiori doi sono dicti duali : doi altri incisui : doi altri canini : quattro maxillari : et sei molari che sono in tuto sedici : & altratanti superiori. Forno facti li denti : prima per masticare el cibo acio che meglio si digesta : secundo per la uoce et distinctione de la eloquela cusi como furno facti li labri. Onde quilli che manchano de denti o de labri non proferiscono bene.

Da poi tu uederai el palato el quale ha una certa concauita ne la sumitate acio che la uoce habbia el suo tono : et etiam chel cibo quando se masticha meglio si possa reuolgere per bocha :

Ne la fine del palato tu uederai una carne pendente in modo de uno grano duua : impero si chiama uuula : et e de substantia rara e spongiosa per che fu facta principalmente a receuere la humidita che descende dal capo acio non descenda a membri inferiori impero spesso se tumefa dicta uuula : fu facta etiam dio acio che temperasse et modulasse la uoce refrangendo laiere che uiene dal polmone : et etiam che lo aiere atrahato al polmone lo ritenga al quanto reperiendolo acio che cusi frigidu non peruenga al polmone [folio 15 recto] ma alquanto alterato : e per questa ragione appare che quilli che hano tagliata la uuula sono molto catarosi impero comandano i medici che non se taglie quando e apostomata : ma che se cauterige cum fuoco.

Dapoi la uuula sono le fauce : e sono li luochi ampli glandosi disposti a receuere le superfluitate del cerebro impero facilmente se apostemano.

Dapoi e la lingua laquale e fabricata et ligata a losso posteriore del capo dicto lauda facto a modo de uno Λ per abacho e fu composta di carne, panniculo, uene, artharie, et noue muscoli : e forno facti tanti muscoli in essa per che se douea molto mouere per ogne uerso secondo el bisogno de la loquela : Et fu in essa piu uene artharie e nerui che in qualoncha altro membro rispetto de la sua grandeza : et fu facta la lingua acio che fusse organo del gusto per nerui che uengono dal terzo pare di nerui gia dicto circa la sua radice : et sono de due facta nerui che uengono a la lingua cio e uno paro di nerui motiui a darli el moto : et uno altro paro di nerui sensitui a darli el gusto : et tu uederai che li nerui motiui piu se profundano ne la lingua per darli el mouere : et li nerui sensitui sono piu expansi ne la superficie : et nel suo panniculo a darli el gusto e el tacto : Fu etiam facto la lingua che deseruisse al proferire de le parole : et etiam a reuolgere el cibo per bocha quando se masticha.

Circa [folio 15 verso] la radice de la lingua da ciascuno lato sono carne glandose facte acio che generasseno la humidita saliuale che hauesse a humetare la lengua acio che non se siccasse per tanti mouimenti che ha in se : et in queste carne glandose sono dui buchi che poria intrare uno stile e per quilli buchi se distilla la humidita saliuale. Sotto la lingua sono doe uene grande uiride da le quale poi procedeno piu altre uene.

Et nota che la migliore lingua quanto al deseruire al parlare e la lingua che e mediocre ne la longitudine e sua latitudine cio e che non sia troppo longa ne troppo larga : e che apresso de la punta et extremita sua exteriore sia sutile per che la lingua che e longa larga e grossa o uero troppo piccola non e conueniente al parlare.

Nota etiam che la lingua ha colligantia cum el cerebro mediante li nerui che uengono ad essa et cum el figato mediante le uene : et cum el core mediante le artharie et cum el stomaco mediante el meri : et cum el polmone mediante la cana de esso polmone : impero in ciascuna infirmita i signi de la lengua sono molti efficaci a iudicare di tale infirmita : e quiue se finisce la anothomia del primo membro principale cio e [el] cerebro e del suo habitaculo.

Tractatus secundus de anothomia membrorum spiritualium et secundi membri principalis: capitulum primum de anothomia gulae et colli.

[folio 16 recto] Finito el primo membro principale e ueduta la anothomia del suo habitaculo e de le altre camare deseruente a quello resta a uedere la anothomia di gli altri membri principali: E prima uederemo la nothomia del collo e de la gola che e condotto e meato dal primo membro principale a gialtri. Diciamo adoncha che la gola si e uno certo spatium nel quale sono doe uie una che mena el cibo al stomaco: e questa se chiama meri: Laltra uia mena laiere al pulmone a refrigerare el core: & etiam mena fuora laiere e uapori caldi da esso core: Onde se tu scarni el collo e la gola tu uederai certi muscoli longitudinali sopra liquali nota le uene da tuti doi li canti: et eleuati quilli muscoli tu uederai doe carne ala forma de doe mandole ne la radice de la lingua: una da ciascuno lato: de le quale habiamo dicto parte disopra: et anche noi dicemo che sono como doe orecchiette piccole, e sono neruose acio [che] siano forte et aiuteno a fare penetrare laiere a la canna del pulmone: et etiam queste tale amigdale hano a congregare una certa humidita per humettare la lingua como e stato dicto et per humettare etiam la canna del pulmone acio [che] non se dessicasse: et anche acio che reimpiesseno i luochi uacui de la gola: et anche acio che fusseno scuto e tutella de le uene & artharie che ascendeno al capo: Onde per questo collo e gola passano le uene dal figato ascendendo al cerebro a darli el nutrimento [folio 16 verso] per esso anche passano le artharie che ascendeno dal core al cerebro a darli la uita: et aciochel spirito uitale per esse uada al rethe mirabile delquale e stato dicto douenti animale e chiamase queste artharie apoplectice per che quando se opillano generano la poplesia cio e el male de la gozola prohibendo el transito del spirito. Per questo etiam collo passano i nerui che descendeno dal capo ai membri inferiore a darli el sentire et el mouere: e tute queste parte potrai uedere escarnando e tagliando el collo e la gola per lo longo.

Capitulum secundum de anothomia pulmonis et tracheae artharie; id est cane pulmonis.

Vediamo hora la anothomia del core el quale e laltro membro principale: e del suo domicilio nel quale e anche collocato el pulmone como quello che serue ad esso core.

Volve Aristotilechel core fusse el primo principio e cagione de tute le operatione del corpo: e che fusse principio del sentire e del mouere e del nutrire e del uiuere e che li era solo uno membro principale: e che el cerebro e el figato erano suoi ministri: ma questo non piaque a Galieno ne a li altri medici liquali per hora noi seguitemo.

El domicilio adoncha del core si e el luochodel pecto circundato da le coste dala parte dinanzi e da la parte de drieto [folio 17 recto] da uno certo panniculo chiamato mediastino e da la parte di sopra el comenza dal principio de la canna del pulmone et terminase ale parte di sotto a uno paniculo chiamato diafragma. Comentiamo aduncha ala parte disopra cio e dal principio de la canna del pulmone e diciamo che el meri cio e la uia del cibo et la trachea artharia cioe la canna del pulmone che e uia de lo hanelito comentiano in uno medesimo luochodel core: Et impero fece la natura uno cooperatorio al principio de la canna del pulmone de una carne carthilaginosae panniculosa anexa al palato sotto luuola e questa carne copre lorificio de essa canna

del polmone el quale orificio si chiama epiglotta : acio che ne lhora del transglutire niente del cibo e del potto descendesse a la uia del polmone per che indurebbe suffocatione : Impero aduiene che se uno ridendo transglutisse qualche cosa ua al polmone et appare che lhuomo se soffochi per che ne lhora del ridere se apre lo epiglotta : Lieua adoncha el meri da la trachea artharia acio che tu uidi la compositione sua : ma sapii che el meri e la trachea facilmente se seperano per insino al epyglotta cio e al orificio de essa trachea ma circa lo epyglotta cum difficulta se seperano per che la tunica del meri si e dispersa ne lo epyglotta : e questo fece la natura sagacemente acio che ne lhora del transglutire del cibo quando [folio 17 verso] el meri se lieua uerso la bocha ad atrahere el cibo anche lo epyglotta se lieua acio che remanendo gioso per la sua durezza non impedisse el transito del cibo.

La trachea artharia o uero canna del polmone e composita de anuli carthiluginosi e panniculosi e de ligamenti che continuano quilli anuli insieme facta da la natura a transportare laiere al polmone per auentare el core : & a transportare fuora i uapori caldi da esso et etiam fu facta a formare la uoce ne la sua extremita cio e ne lo epyglotta : Questa canna bisogno che fusse carthiluginosa et alquanto dura et non pelliculare e molle perche bisognaua stare aperta essendo uia de laiere : e non fu etiam ossuosa per che douea essere flexibibile per la formatione de la uoce : et anche se fusse ossuosa impediria el transito del cibo per el meri quando fusse troppo : Et per questa ragione la carthilagine di questa canna non fu una ma furno piu continuate per certe pellicole insieme : e queste sono facte como certi semi-circuli in modo de uno C per che se fusse una carthilagine seria dura e comprimirebbe el meri et impediria el transito del cibo. Onde questa cana ne la parte anteriore e carthiluginosa per che uerso quella parte non tocha el meri et anche acio che sia piu difesa da le cose esteriore ma uerso la parte posteriore e pelliculare per insino a lo epyglotta : La quale poi tuta e carthiluginosa [folio 18 recto] per la ragione dicta : e questa canna del pulmone non descende se non insino a la furcula sotto laquale e incontinenti situato el pulmone : et el sito de essa e ne la parte dinanzi : et dritamente procede e non storta acio che laiere habbia piu libero ingresso : et lo epyglotta che e principio di questa canna si e tuto carthiluginoso acio che sia piu sonoro : et e apresso la bocha acio che sia instrumento dela uoce : laquale poi ne la bocha douenta locutione per che la uoce finalmente ne lhuomo se ordina al parlare. Questo epyglotta e composto de tre carthilagine e uinti muscoli : Una carthilagine si e ne la parte anteriore e chiamasi clipeale a modo de uno capello : Laltra si e ne la parte posteriore uerso el meri e questa non ha nome : La terza si e in mezo di queste doe et in essa e una languetta in modo de una lingua de zalamella e chiamasi questa carthilagine fistula de lo epyglotta per che como la fistula se ordina nel sono cusi questa carthilagine si e ordinata al canto e la melodia : Questo epyglotta etiam e composto de uinti muscoli a dare el moto uoluntario secondo el bisogno de formare la uoce : e dodici di quisti sono da la parte di dentro e octo dala parte de fuori et a quisti muscoli uengono dui nerui che hano origine dal sexto pare de nerui del cerebro dicti : di quali una parte descende per insino al core e poi comenza a reascendere per insino a lo epyglotta impero [folio 18 verso] sono dicti nerui reuersiui li quali sono nerui de la uoce e quando sono alo epyglotta se spargeno inquisti uinti muscoli a darli el sentire e el mouere. Questi nerui forno reuersiui e non directi per molte cagione : prima acio [che] fusseno piu forti per che quanto el neruo e piu remoto dal cerebro tanto e piu sicco e forte : La seconda acio [che] fuseno facti a modo de uno freno da cauallo acio chel cerebro meglio mouesse lo epyglotta secondo lo imperio de la sua uolunta mediante questi nerui como lhuomo moue el cauallo al suo libito mediante

el freno : La terza cagione e per che la uoce non solo depende dal cerebro como dal principio del moto uoluntario ma etiam depende dal core como da quello nel quale se formano i concepti del cerebro et consequenter i concepti de la uoce : bisogno adoncha che dicti nerui comunicasseno al core : La quarta cagione e per che quisti nerui douendo uegnire ali muscoli predicti bisogno che uigniseno al principio de dicti muscoli e non a la fine : et el principio di quisti muscoli de lo epyglotto e ne la parte inferiore.

Da poi la trachea artharia tu uederai el pulmone ala compositione del quale concorreno piu parte ramificate como fili sutili ad ordire la sua substantia : La prima parte che entra ne la substantia del pulmone si e la trachea artharia laquale [folio 19 recto] como giunge a la furcula del pecto se diuide in doe parte : una ua al dritto e laltra al sinistro del pulmone e ciascuna di quelle se diuide in doe altre parte cio e superiore et inferiore : e ciascuno de quilli rami : se diuide etiam in rami minori e cusi diuidendosi peruencono a rami minimi como fili e circundano tuta la substantia del pulmone. Una altra parte che ordisse la substantia del pulmone si e una certa uena che ha origine dal uentriculo dritto del core laquale porta el sangue sutile dal core a nutrire el pulmone : e chiamasi uena arthariale Vena per che non pichia arthariale per che e composta de doe tuniche como sono le artharie : e questa uena se ramifica ne la substantia del pulmone como la trachea artaria.

La terza parte che compone el pulmone si e una certa artharia che nasce dal sinistro uentriculo del core dicta artharia uenale : Artharia per che pichia Venale per che e composta de una tunica como le altre uene et per questa artharia se transporta dal pulmone al core laiere che uiene da la trachea artharia a refrigerare esso core : Et per questa artharia etiam se manda dal core al pulmone laiere e uapori caldi e dal pulmone poi escono fuori per essa trachea e questa artharia similiter se ramifica como le altre doe parte predicte : Onde li rami de la trachea [folio 19 verso] e de lartharia uenale e uena arthariale compongono tuto el pulmone in modo de una rethe : et i buchi de questa rethe reimnisse una certe carne molle spongiosa laquale proprio e substantia de esso pulmone : Et tute queste quatro parte predicte sono inuolute da uno certo panniculo che ha origine da uno panniculo che e sotto le coste chiamato pleura del quale poi se dira per questo panniculo ha el pulmone el sentimento per che el pulmone non sente secondo la sua substantia.

Et nota che li rami de la trachea artharia sono maggiori che li rami de la uena arthariale, et de la artharia uenale per che nascono da maggiore troncho et etiam nota che el pulmone e maggiore ne la parte dritta che ne la stanca per che dal lato stancho glie el core che occupa quello luocho : Similiter e maggiore ne la parte posteriore che ne la parte anteriore : Questo membro sie como flabello del core a refrigerarlo et etiam a mondificarlo da li uapuri che continue se generano in esso : impero e seruo e ministro del core.

Capitulum tertium de anothomia cordis quod est secundum membrum principale.

Dapoi te apparera el core nel mezo del pulmone cooperto da le sue penole acio che laiere atrahatto da esso pulmone lo refrigerare, e del suo caldo e spirito se tempi : Questo membro tra lialtri quatro e principalissimo per che e el primo che ne la generatione [folio 20 recto] uiue et e lultimo che more. Questo membro e de mediocre quantita per rispetto di li altri membri de lhuomo : ma per respecti di li cori de lialtri animali e molto grande perche lhuomo ha piu del caldo naturale che glialtri animali quantitatie et non

intensiue : Et e di figura pyramidale cio e de la forma del fuocho per che esso e de eccellente calidita impero bisogno che fusse de una figura che asomigliasse a la figura del fuocho : e questa tale figura se chiama pigneale cio e simile ala figura de una pigna laquale e lata disotto e stretta di sopra et di tale figura fu facto acio che meglio se facessero distinctione de le sue cellule o uentriculi : et etiam se fusse stato de una figura tuta uniforme como e la parte disotto seria stato troppo graue e ponderoso. Questo membro e situato nel mezo de tutto el corpo tolti uia glie extremi cio e nel mezo de la parte superiore et inferiore : nel mezo de la parte dinanzi e de dietro, e nel mezo de la parte dritta e sinistra como uno re che sta nel mezo del suo regname e questo fu facto acio [che] potesse equalmente dare la uirtu de la uita a tuti membri : E benche el core sia quanto al suo fondamento et ala sua base nel mezo tamen secondo la sua punta declina al lato stanco sotto la mamilla sinistra acio che riscaldasse la parte sinistra como el figato riscalda la parte dritta : e questo [folio 20 verso] membro se sustenta e ferma de uno certo osso cartilaginoso per che e in continuo mouimento : bisogno aduncha che hauesse uno apogiamento alquale se fermasse nel suo mouimento : Et e etiam composto de una certa pinguedine ne la parte esteriore acio che prohibisca chel core non se desichi tenendolo humectato : Et e composto di certe uene et artharie disperse per la sua substantia : et e composto etiam di de una certa carne dura per che haueua a sustignire de molti e forti mouimenti : Et etiam fu composto de uili longitudinali latitudinali e transuersali per che bisognaua che hauesse uirtu de atrahere retignire et expellere : E questo membro ha tri uentriculi o uero tre cellule como ha el cerebro. Uno uentriculo e dal lato dritto e laltro dal lato stanco e el terzo e in mezo : el uentriculo dritto uerso el figato : el quale ha doi orificii : uno e uerso el figato et e molto grande nel quale entra una uena chiamata uena chilis laquale nasce dal gibbo del figato e porta el sangue dal figato al core : Et in questo uentriculo dextro del core se purifica quello sangue e cusi purificato poi lo manda el core a tuti li altri membri : e per che per questo orificio ha el core piu ad atrahere che ad expellere impero ordino la natura che ne lhora de la constrictione quando de expellere che questo orificio se chiudesse : e che [folio 21 recto] quando el core se dilatta se aprisse : Et iui sono tre hostiolitti o uero usitti liquali se apreno da fuora adentro : e questi hostioli non sono molto depressi e per che per questo medesimo orificio se expelle el sangue depurato agli altri membri ma non tuto per che una parte ua al polmone e de laltra parte se ne fa spirito uitale : impero ordino la natura che questi hostioli non se chiudessero in tuto : E da questa uena chilis inanzi che entri la concauita del core nasce un altra uena laquale circonda la radice del core e da quella nascono alcuni rami che se dispargono per la substantia del core : E del sangue de questa uena se nutrisse esso core.

Uno altro orificio ha questo uentriculo destro uerso el pulmone nel quale entra la uena arthariale che porta el sangue dal core a nutrire el pulmone : Et in questo orificio li sono etiam tri hostioli liquali se apreno de la parte dentro a la parte difuori e se chiudeno da la parte difuori a la parte di dentro per el contrario di li hostioli de laltro orificio : e questo e per che in tuto se chiudeno : Onde per questo orificio el core ne lhora de la constrictione solo ha ad expellere : e ne lhora de la sua dilatatione non ha ad atrahere alcuna cosa como faceua nel primo orificio.

El uentriculo sinistro del core ha i lati piu densi e piu spissi che li lati o uero parieti del uentriculo dextro : e questo [folio 21 verso] fu per tre ragione : La prima per che nel uentriculo dextro se de contenere el sangue el quale e graue E nel uentriculo sinistro se de contenere el spirito el quale e molto ligiero : acio aduncha chel core non fusse piu graue e ponderoso da

una parte che da l'altra bisogno recompensare in questo modo cio e che lo uentriculo stancho hauesse piu grossezza ne li suoi parieti che el dextro : La seconda cagione e che essendo el spirito piu sottile e piu resolubile chal sangue bisogno adoncha che el suo habitaculo hauesse piu grosso e de migliore sponde : La terza cagione si e per che el uentriculo sinistro e molto piu caldo cha el dextro per che iui se genera el spirito dal sangue per una grande calidita che sottiglia quello sangue e la calidita meglio se conserua nel subiecto denso e grosso :

Ne la concauita di questo uentriculo circa la sua radice li sono dui orificii : uno si e lorificio de una artharia chiamata artharia adorti per che immediate ha origine dal core e per che e principio de la origine de tute le altre : per laquale artharia manda el core el spirito generato a tuti i membri : et etiam el sangue molto sottile insieme cum el spirito e questo fa quando el core se constringe : Onde nel principio di questo orificio li sono tri hostioli liquali in tuto se chiudeno da la parte difuori a quella dentro : e se se apreno da la parte dentro a la parte difuori e questo [folio 22 recto] orificio e molto profundo.

Laltro orificio si e de lartharia uenale laquale transporta laiere dal polmone a refrigerare el core e transporta i uapori caldi dal core al polmone como e stato dicto disopra : Et in questo orificio li sono doi hostioli che non se chiudeno altuto : Et sono molto eleuati acio che se apogiono melglia a la sponda del core quando el manda el spirito : Queste sono mirabile opere de la natura como anche mirabile opera fu nel uentriculo mezo del core per che questo uentriculo non ha una concauita ma piu lequale sono piccole ma larghe e piu nela drita parte che la sinistra : E questo fece la natura aciochel sangue che ua dal drito uentriculo al sinistro per conuertersi in spirito continuamente se uegna sottigliando per quelle concauita.

Et per questo tu poi uedere che dal core nascono quatro cose cio e lartharia chiamata adorti : L'altra si e la uena chilis : la terza si e la uena arthariale : e la quarta si e artharia uenale.

Anche uederai nel core certe parte pelliculare & in modo de auricule o uero orecchiette apte a dillatarsi e constringersi facte da la natura acio che quando nel core se genera molto sangue o molto spirito se potesse el core dilatare a contenere quello sangue o quello spirito multiplicato et anche se constringa quando non glie tanta habundantia di sangue o de spirito.

E qui adimanda Galieno [folio 22 verso] per che non fece la natura el core si grande che potesse contenere ogne multitudi de sangue e de spirito senza quilli adittamenti di quelle pellicule. Risponde Galieno che questo fu : prima perche el core seria stato tropo grande : et consequenter tropo ponderoso : Secundario per che non se generando sempre molta quantita de sangue o de spirito sel core fusse stato tropo grande per la piu parte de le uolte la concauita del core seria stata uacua : ma queste tale auricule se dillatano ne lo aduenimento del sangue o del spirito e cusi se stringono ne la paucita soa.

Questo core e circumdato da uno panniculo duro neruoso o uero pelliculare facte in modo de una cassetta nel quale e posto el core como in uno suo tabernaculo a diffensarlo da le cose occurrente : Et questa capsula molto dilatata aciochel core ne la sua dillatatione e mouimento non fusse agrauato da essa : Et etiam fece la natura questa capsula acio che continesse una certa aquosita rorida de laquale se bagnasse et humetasse el core acio che per el suo continuo mouimento non se sichasse : Onde quando questa aqua che e ne la capsula del core sie desiccata etiam se desicca esso cuore et consequenter se demacra e desicca tuto el corpo.

*Capitulum quartum de anothomia trium panniculorum interiorum
scilicet mediastine, pleure, & diafragmatis.*

[folio 23 recto] Tri sono li panniculi interiori di questo domicilio del core : Uno che se chiama mediastino che diuide la concauita del pecto per mezo cio e la parte dinanzi da la parte de drieto et consequenter diuide el pulmone per mezo : e questo panniculo non e neruoso ne anche e ueramente uno continuo como li altri paniculi : e questo ha facto la natura per alcune utilita : prima acio che se una parte del pulmone receuesse nocumènto di qualche superflui humuri che se agregasseno in quella non peruegnisse el nocumènto e non regurgitasse quella materia a l'altra parte ; Secundario acio che tenesse suspeso e ligato el pulmone al pecto.

El secondo panniculo chiamato pleura e uno panniculo duro e neruoso e molto grande : el quale copre tute le coste da la parte dentro : impero ha colligantia cum tuti li membri liquali se contengono ne la concauita del pecto e questo panniculo fece la natura acio che cuprissse tuti quilli membri a sua tutela ; et acio che li paniculi dili membri tuti del pecto hauesseno principio et origine da quello.

El terzo panniculo se chiama Diafragma e da Aristotile e chiamato diazona per che e como una cintura che cinge per mezo : Questo panniculo e muscoloso cio e carnosio e neruoso et e situato ne la fine del pecto e de le coste e ne la parte dinanzi quanto a la parte sua [folio 23 verso] carnosia e continuato cum le carthilagine de le coste mendose, e ne la parte posteriore e continuato cum la duodecima spondile doue sono le rene : De le coste e di li spondili poi noi diremo.

La utilita de questo panniculo prima fu acio chel seperasse li membri spirituali da li membri naturali cio e el secondo domicilio dal terzo acio che li fumi leuati da le feze non peruegniseno a li membri spirituali : Secundario per che ha a mouere el pulmone al mouimento de lo hanelito : e questo panniculo benche cingha per mezo oblique tamen et non ex directo : e la cagione di questa obliquita sie che da questo panniculo insieme cum el myrach del quale poi noi diremo se comprimino le feze che sono ne lintestini ne lhora de la egestione como se fusseno tra doe asse de uno torchio : E quanto a la parte meza di questo panniculo laquale e neruosa e panniculosa e colligato cum el pulmone per darli el mouimento como e stato dicto mediante i nerui quali uengono ad esso dal cerebro e da la nucha e per questo appare la cagione de la diuersita de el Diafragma e de li altri muscoli per che li altri muscoli nel luocho doue se congiungeno cum el membro quale debeno mouere sono como corde e ne li altri luochi sono carnososi per che sono facti principaliter a mouere le osse : ma nel diafragma e tuto el contrario per che fu instituito principalmente [folio 24 recto] a mouere el pulmone e non le ossa, e per questo appare chel diafragma sie rotondo cum una certa longitudine e che la sua substantia e muscolosa e cordosa e che le utilidade sue sono tre : Prima acio che sia principio del moto de lo hanelito : Secundo acio che diuida tra membri spirituali e naturali : Tertio acio che aiuti el mirach ad expellere le superfluita quale sono ne lintestini.

*Capitulum quintum de anothomia pectoris seu toracis continentis
membra spiritualia.*

Dicto di li membri che sono contenuti dentro dal pecto : poniamo adesso la anothomia de esso pecto : e disopra habiamo dicto che glie uno paniculo chiamato pleura quale copre tute le coste da la parte di dentro : Da poi quello

panniculo tu uederai le ossa le quale sono di doe maniere cio e le coste e li spondili che sono como sponde doue se apogiano le coste lequale sono dodece da ciascuno lato cio e septe uere e cinque mendose : Le coste uere sono continuate cum li spondili a coprire et perficere el pecto : ma le mendose non : et una costa non attinge l'altra ne la extremita acio che meglio se possa dilatare e constringere el pecto : Li spondili sono septe che se coniungono cum le septe coste uere mediante certe cartilagine lequale sono tra luno e laltro : e da queste carthilagine cum le sue ossa [folio 24 verso] se compone uno membro chiamato la furcula del pecto facta a modo de una furcula bifurcata ; e ne la extremita sua li e una certa carthilagine facta a modo de uno scuto a custodire la bocha del stomacho e chiamasi pomo granato : Da li lati de le coste mendose sono certe carthilagine.

Da poi uenendo a le parte de fuora : sono alcuni musculi di li quali alcuni sono a dillatare el pecto e sono dui musculi del Diafragma posti ne le parte inferiore del pecto : et hano a dillatare el Diafragma et consequenter el pecto ne la parte inferiore doue e una grande spaciosita : Item li sono dui altri musculi liquali sono nel collo et hano a dillatare la concauita superiore del pecto la quale e picola. Item sono altri musculi ne la schina doue e la origine de le coste, e comenzano apresso la origine de la prima costa : Item sono molti altri musculi piccoli liquali cum difficulta se possono uedere ne la anothomia : e tuti quisti musculi predicti sono solo a dillatare.

Alcuni altri musculi sono a dilatare e constringere e sono situati tra le coste perche tra ciascuna doe coste li sono doi musculi di liquali uno ha li uili latitudinali a dillatare, e laltro ha li uili transuersali a constringere.

Oltra questi musculi appare la pinguedine le mamille e la cute : La cute e la pinguedine e asai manifesta [folio 25 recto] impero solo noi diremo de la anothomia de le mamille e haueremo fornito la anothomia del secondo domicilio e del secondo membro principale.

Capitulum sextum de anothomia mamillarum et de utilitatibus earum.

La figura de le mamille si e in modo de una çucha rotonda per che bisognaua essere capace del sangue che se ha a conuertere in lacte e la figura rotonda e piu capace cha le altre : et etiam per che le mamille sono como scuto del core impero doueano hauere una figura piu secura da li nocumenti : e questa tale figura e la rotonda.

Le mamille hebbeno doi capi piccoli acio che la creatura potesse succiare el lacte : E la substantia sua si e certe carne glandose le quale de sua natura sono frigide acio che el sangue douenti bianco in esse e questo non se fa senon per infrigidatione del dicto sangue.

La quantita de le mamille ne la dona e maggiore che nel maschio per che bisognaua generare el lacte ne la dona e non nel maschio. Et etiam essendo la femina piu frigida chel maschio bisogno essere maggiore le mamille in esse acio che facesseno maggiore reuerberatione del caldo al core et per questa reuerberatione lo fortificaseno.

Le mamille ne lhuomo fono facte due como in tuti li altri animali che generano una o doe creature : ma ne [folio 25 verso] ghaltri animali che generano piu figlioli sono facte piu mamille.

Ne lhuomo fono situate nel pecto e ne li altri animali nel uentre : e questo fu per molte casone : La prima secondo Galieno e chel sangue del quale se genera el lacte deba essere ben digesto impero bisogno essere propinque al core ne lhuomo per la cui calidita quello sangue fusse meglio digesto : ma ne li altri animali molta quantita de tale sangue superfluo ua a conuertirse in corni o in altri membri.

La seconda cagione aseгна Aristotile che li altri animali hano le gambe dinanzi molto strette et impero hano el pecto molto stretto : ma ne lhuomo el pecto e amplo : onde non potete la natura situare le mamille ne gli altri animali como ne lhuomo.

La terza cagione si e chel core de lhuomo hebbe bisogno de essere piu deffensato che el core de li altri animali li quali li hano pili disopra impero fece la natura le mamille como defensaculo ne lhuomo che non ha pili in quelle parte.

Le mamille hano colligantia cum el core e cum el figato per una certa uena che ascende dal figato ad esse mamille : ha etiam dio colligantia cum la matrice mediante certe uene che uengono da la matrice ad esse e procedeno quelle uene tortuose acio che continuamente se asuttiglie el sangue e meglio se digesta a conuertirse in lacte.

[folio 26 recto] *Tractatus tertius de anothomia tertii membri principalis scilicet epatis et eidem deseruientibus : capitulum primum de anothomia stomaci.*

Veduto de doi membri principali et di li suoi ministri et etiam de li suoi domicili vediamo mo la anothomia de doi altri membri principali cio e figato e testicoli et di li membri che sono suoi ministri et etiam de li suoi domicili : E noi determinaremo de tuti dui quisti in questo tractato per che li membri che deserueno a la generatione non hanno distincto domicilio da li membri nutritiui : E questo domicilio comenza dal pomo granato che copre la bocha del stomaco del quale habiamo dicto e dura per insino al petenechio inclusiue includendoli la uirga e li testicoli : et questo e quanto per lo longo, ma quanto per el largo dura da uno fianco a laltro e per el profondo dura da la cute de lombelico che copre el corpo dinanzi dale coste ingioso per insino a laschina de drieto :

In questo domicilio li sono contenuti di molti membri cio e stomaco, intestini, figato, fele, milza misinterii, girbo, rognoni, vesica, testicoli, vasi spermatici, matrice ne la femina, e la uirga ne lhuomo de liquali membri solo dui sono principali cio e el figato et li testicoli secondo Galieno, o uasi spermatici secondo Aristotile.

Noi adoncha sequitaremo secondo el nostro ordine consueto comentando a li membri superiori e descendendo a linferiori. Comentaremo [folio 26 verso] adoncha dal stomaco e dal meri che e uia del cibo ad esso stomaco, E noi habiamo dicto di sopra che como la cana del pulmone era conducto de laiere cusi el meri era conducto del cibo e del poto : E che la bocha de la cana del pulmone e la bocha del meri erano congiunte insieme per la rason e iue dicta.

La sustantia di questo meri sie pelliculare e molle como la cana del pulmone e pelliculare e carthilaginosa e bisogno chel meri fusse molle acio potesse dilatarsi quando lhuomo piglia tropo cibo, et anche questo meri non sta aperta como fa la cana del pulmone ma per la sua mollitie una parte cade sopra laltra.

La substantia del meri e composta de doe tuniche una intrinsecha che ha certi uili o neruetti longitudinale che sono facti ad atrahere el cibo : e laltra sie exteriore ne laquale sono uili latitudinali facti ad expellere quello che e stato atratto da la tunicha interiore : benche la prima tunicha sie piu principale che la seconda.

La quantita del meri e magiore che non e la quantita de la cana del pulmone per che el meri ua piu longo che non fa essa cana : Onde el meri

ua per insino al diafragma e desotto da esso se continua cum la bocha del stomaco onde el stomaco e incontinenti sotto el diafragma : Et anche el meri e magiore in largheza per che hauea a passare per esso cosa piu grosa che non e [folio 27 recto] laiere.

Questo etiam Meri e posto piu nel profondo uerso le parte posteriore cio e uerso la schina doue ua a ritrouare la bocha del stomaco laquale bocha e uerso le parte posteriore : per che la bocha del stomaco e ligata ala schina ex directo in el principio de la sua ligatura cio e a la decima terza spondile sotto el diafragma : el quele se termina ala duodecima spondile e poi consequenter procede el stomaco aligandosi ali spondili de le rene.

Questo stomaco sie cella del cibo et e quasi in mezo de tuto el corpo como e stato dicto del core : per che essendo como lauezo doue se ha a cocere el cibo bisogno essere in mezo acio chel receuesse calore da tute le parte e da tuti li membri circumstanti : et non fu posto el stomaco apresso de la bocha per la rasona dicta : Tu uederai adoncha el stomaco hauere sopra si el core e el diafragma e desotto el misinterio e lintestini : da la parte dritta el figato el quale lo abraza cum cinque sue penole : da la parte sinistra la milza laquale li rende calore mediante le sue artharie : da la parte dinanzi ha una rethe chiamata el Girbo : da la parte de drieto li muscoli de la schina e una uena grande e una artharia che passa per la schina como poi se uedera : da tuti quisti membri receue calore el stomaco acio che coza bene el cibo.

E ben chel stomaco sia situato sopra de la Schina niente di meno la parte sua superiore declina al [folio 27 verso] lato stanchi, e la parte inferiore al lato drito : e questo fu per che ne la parte dritta li e el figato molto eleuato ne le parte superiore, e la milza ne la parte stancha e piu de pressa : impero la parte superiore del stomaco non se potete locare ne la parte dritta per che el figato occupaua quello luocho ma ben se potete locare ne la sinistra cio e disopra dala milza doue li era uacuita. Item per che disotto dal figato li sono glintestini suttili e gracili liquali occupano pocho luocho et iue remane una grande concauita impero fu locata la parte inferiore del stomaco iue a reimpiere quella concauita : Et per che etiam ne la parte stancha disotto da la milza apresse de le rene glie uno intestino molto grosso chiamato colon el quale occupa una grande luocho impero non se potete locare dicta parte inferiore nel lato stanchi.

Una altra cagione per laquale el stomaco non fu posto a presso de la bocha e perche apresso de la bocha bisognorno essere i membri de lo hanelito ad atrahere laiere : Et anche per che el bisognaua che glintestini fusseno continuati cum el stomaco, e bisognaua che glintestini fusseno disotto dal diafragma.

Et per questo appare che per molte cagione el stomac non fu locato per el dritto ma per lo storto e per lo obliquo : la prima si e gia dicta acio reimpisse la uacuita de la parte dritta e stancha : La seconda per che essendo lhuomo de statura dritta non retigniria bene el cibo [folio 28 recto] ma subito uscirebe fuori per la bocha disotto : La terza cagione per che bisognaua chel stomaco receuesse da la milza quanto a la bocha superiore lhumore melenconico a darli lapetito : et quanto a la bocha disotto bisono che receuesse lhumore collerico dal figato : et impero bisogno che la bocha superiore del stomaco fusse dal lato stanco doue e la milza e la bocha inferiore fusse dal lato dritto doue e el figato.

E per questo appare chel stomaco ha colligantia cum la milza per certe nene che portano lhumore melenconico ad esso : et ha similiter colligantia cum el figato per molte altre uene che li portano el nutrimento dal figato : et ha colligantia cum el core mediante una grande artharia che e posta sotto esso : et ha colligantia cum el cerebro mediante uno certo neruo el quale ua ala

bocha del stomaco et iue se sparge e diuidese circa la superiore parte de esso stomaco.

La figura del stomaco fu rotonda acio che fusse piu tuta da li nocumenti extrinseci et acio anche che fusse piu capace per che bisognaua continere di molto cibo : Ma non fu perfettamente rotonda per la rasone dicta per che bisognaua che una parte declinasse al lato dritto e l'altra al lato stanco impero e di figura arcuale in modo de una cucha ritorta e fu molto grande el stomaco acio potesse receuere grande quantita de cibo.

El stomaco e composto de due tuniche : Una interiore laquale e neruosa e l'altra [folio 28 verso]exteriore e carnosa : Et la prima tunica neruosa e piu grossa e spessa che la seconda per che hauea a tohare el cibo acio che non receuesse nocumento da esso e per che se potesse dilatare e constringere secondo el bisogno de la quantita del cibo : ma la tunicha exteriore fu piu sottile onde e da notare che la tunicha interiore bisogno essere neruosa per molte rasone : prima per che in essa & de essere lapetito e el sentimento e non e dubio che meglio se sente la cosa quando senza mezo ocorre al sentimento : ma la exteriore fu carnosa facta a digerire et alterare el cibo : la alteratione e digestion se puo ben fare per mezo e non occorrendo in mediate a la cosa : Questa tunicha adoncha exteriore e piu sottile che la interiore per che e aiutata dai membri circumstanti a digerere : non bisogno essere adoncha troppo grossa.

La tunicha interiore e deputata ad atrahere el cibo et a retignirlo debito tempo per insino che se digestisse : impero ha alcuni uili longitudinali ne la superficie interiore mediante li quali atrahe a se el cibo : e ne la superficie exteriore ha alcuni uili transuersali per liquali ritiene el cibo Et la tunicha exteriore ha a digerire el cibo et consequenter ha ad expellerlo quando e digesto : impero in essa certi uili latitudinali sono posti per liquali ha ad expellere el cibo digesto :

La bocha del stomaco superiore e piu lata che non e la inferiore per che [folio 29 recto] per la bocha disopra hauea intrare el cibo grosso indigesto e per la bocha disotto hauea uscire el cibo sottile e digesto : E quisti doi orificii non sono facti molto eminenti ma la parte inferiore del stomaco e piu disotto che la bocha inferiore aciochel cibo se retegna et similiter la parte superiore del stomaco e piu eminente e piu insuso che non e la bocha superiore acio che essendo el stomaco pieno de cibo inclinandosi lhuomo cum la bocha in giu non ritornasse el cibo fuora.

Doe adoncha sono le utilita del stomaco : Una ad appetere el cibo necessario per tuto el corpo : e questo fa per la tunicha neruosa interiore e l'altra e a digerere el cibo e questo fa per la tunica exteriore carnosa.

Capitulum secundum tractatus tertii de anothomia intestinorum et misinterii.

Dapoi el stomaco li sequitano glistestini li quali sono sei reuoluti cioe tri sottili e tri grossi et non fu ne lhuomo uno solo intestino recto ma furno piu e circumuoluti aciochel cibo longo tempo se continesse nel stomaco et intestini per che se cusi non fusse bisognaria che lhuomo fusse in continua asumptione de cibo, et in continua egestion e seria stato lhuomo molto occupato in tale uile operatione Et anche sel fusse stato uno solo intestino recto non seria stato tuto el cibo da ciascuna parte de lo [folio 29 verso] intestino toco et consequenter non seria stato exsiccata tuta lhumiditate del cibo : Acio adoncha tuta la humidita del cibo sia desiccata et atratta al figato e che niente o pocha non rimanga ne le feze : Furno facti piu intestini

circumuoluti : El primo adoncha intestino e chiamato duodeno et e sottile e chiamasi duodeno perche e longo quanto e dodice uolte el dito grosso di quello tale : Et in questo intestino li entra el cibo como e digesto nel stomaco per la bocha de sotto de esso stomaco chiamata portonaria o uero pylorum cum la quale se continua questo intestino duodeno. Digesto andoncha el cibo nel stomaco se apre questo portonario e manda la uirtu expulsiua del stomaco questo tale cibo ne lo intestino duodeno : A questo intestino ua uno canale o uero condotto dal fele per el quale se porta la collera ad esso intestino. Da poi questo intestino li sequitan uno altro intestino sottile chiamato ieiuno perche e la piu parte del tempo uacuo per doe ragione : Prima per che e dritto e non inuoluto : La seconda per che una grande multitudinede collera pura uiene ad esso per quello medesimo condotto che ua al duodeno : e questa collera mordica lo intestino e fa descendere gioso el cibo.

Dapoi sequita el terzo intestino sottile chiamato ileon per che e situato circa gli ilii id est li fianchi : Onde in questo intestino glie uiene el dolore iliaco cio e dolore de fianco e questo [folio 30 recto] intestino hebbe molte inuolutione, et anche ad esso peruengono de molte uene piccole dal figato chiamate mesaraiche : E questo fece la natura acio che el figato atrahesse la humerosita dal cibo per quelle uene, onde a questo intestino li peruengono piu uene mesaraiche che nesuno di li altri.

Dapoi questi tri intestini sutili succedeno li grossi : E questo fu facto per che quanto el cibo uiene piu descendendo tanto piu douentano dure le feze e piu grosse impero bisogno che gli intestini inferiori fusseno piu ampli che li superiori.

El primo adoncha intestino grosso che sequita ali sottili si e chiamato monocolo, non per che habia solo uno orificio per che questo seria impossibile anzi ne ha doi como li altri uno per elquale atrahe el cibo e laltro per elquale expelle : ma per che quisti doi orificii in questo intestino sono uno a presso de laltro como coiuncti e non dispartiti como ne gli altri impere appare hauere solo uno orificio, onde per questo monocolo e chiamato : Et anche chiamato sacco per che pende la sua concauita como un sacco stando li suoi orificii de sopra : Questo intestino e situato ne la parte dritta apresso lancha e disotto dal rognone dritto. E fu facto acio che retinnesse el cibo ançi lo reuerberase a li intestini superiori e prohibisse che non descendesse acio che in quilli intestini se esuccasse dal figato la sua humidita como e stato dicto.

Da poi questo intestino sequita laltro grosso [folio 30 verso] chiamato colon per che ha piu colli o uero cellule ne lequale el stercho receue la sua forma.

Questo intestino ha de molte inuolutione circa el rognon stanco e poi ascende e copre la milza e poi se declina a la parte dritta uendo piu uerso le parte exteriore e copre el stomaco.

E per questo appare la cagione per che fu locato sopra del stomaco e de sopra tuti li altri intestini : questo fu per che era piu ignobile de lialtri, e como membro piu ignobile fu posto uerso le parte exteriore et anche per che le feze se indurano in esso acio che hauesse qualche humidita dal girbo del quale poi noi uederemo. Laltra cagione de cio e che essendo questo intestino facto a continere et expellere le feze ma piu ad expelere impero bisognaua ad esso uenire piu collera che hauesse a stimulare la uirtu expulsiua piu che ne gli altri : impero sopra di quello ne la parte dritta una penula del figato doue e alligata la cеста del fele como appare al sentimento : e questo fu che de sopra de questo intestini li peruenisse la collera oltra quella che ua a la sua concauita como etiam ua a le concauita de gli altri intestini.

La substantia di questo intestino e grossa e solida facta cusi per la

uentosita grande che se genera in esso laquale fa dolore fortissimo chiamato dolore collico : Et in questo intestino se generano certi uermi longi [folio 31 recto] et altre manerie de uermi chiamati lombrici.

Da poi e lultimo intestino chiamato intestino dritto de el quale la extremita et oreificio inferiore se chiama ano o uero culo : e uasene uerso el fianco stancho doue poi comenza lo intestino colon predicto. In questo intestino recto li sono una grande moltitudine de uene meserayce che uengono a sugare se qualche humidita fusse rimasta ne le feze.

Quisti sono adoncha li sei intestini liquali sono alligati a la schina mediante uno certo membro chiamato misinterio o uero intriglio quasi interiora tenens che non solo glintestini ma tute le uiscere sono alligate per questo intriglio ala schina et impero questo membro fu composto de uene, corde, panniculi, e ligamenti acio potesse ligare li predicti membri : Et e etiam e composto de una sustantia seposa e pingue acio che li membri duri como sono li spondili non se congiognesseno senza mezo cum li membri molli cio e cum li intestini e le altre uiscere acio che el molle non receuesse nocumento dal duro. Le altre uacuita di questo membro sono reimpite de certe sustantie glandose, facte etiam acio che sustentino le uene meseraiche che sono disperse in questo membro : et forse che sono facte etiam a generare la humidita che humetti la feze de glintestini acio che piu tosto lubrichi : et impero uedemo che mangiando cibi duri [folio 31 verso] niente dimeno quello che nesce per igestione e liquido.

Capitulum tertium de anothomia epatis quod est tertium membrum principale : et de uenis orientibus ab eo.

Vediamo mo del terzo membro principale situato in questo palazzo et e el figato alquale deseueno tuti li altri membri che sono posti quiue. El figato naturalmente e situato sotto el diafragma et non sotto le coste uere, ma una parte de esso sta sotto le parte mendose : benche ne lhuomo morto appara essere locato tuto sotto le coste, e questo e per che li membri spirituali ne lhumo morto sono molto anihilati et el figato ua a reimpire le uacuita derelicta : impero quando tu fai la anothomia tu dei eleuare el corpo morte e tirare in gioso el figato acio chel uada al suo luochu naturale.

La quantita del figato fu molto granda ne lhuomo per che e molto sanguineo e de natura calda e humida.

El figato sie composto de certe uene diuise e disperse in modo de una rethe et le uacuita sue reimpisse una certa carne rossa che e como sangue coagulato : Et per queste uene se si sparze el cibo digesto nel stomaco chiamato chile cio facto in modo de suco dorzo che cusi douenta nel stomaco, e questo fu facto acio che se diuidesse in parte piccole che tuto el figato potesse tohare tuto quello chilo acio che meglio lo conuertisse in sangue : Ma nel stomaco non sono tal uene doue se hauesse a receuere el cibo ma solo [folio 32 recto] li fece una concauita per che li cibi che se pigliano sono molto grossi che non harebono potuto penetrare per dicte uene. Questa decocione che se fa nel figato a conuertere el chile in sangue piu se compisse ne la parte superiore : et impero quella parte e piu solida e dura : Hebbe el figato cinque penule benche ne lhuomo non siano sempre diuise che se possano uedere.

Questo figato ha doe parte cio e la parte gibosa e la parte concaua, et ha colligantia cum el core per una certa uena che nasce dal suo gibo e uasene al core, et e chiamata uena chilis : Et etiam ha colligantia cum el diafragma alquale sta suspenso Et similiter a li spondili de la schina ala quale e alligato mediante un certo paniculo : Onde ha dui panniculi uno chel suspende e liga

al diafragma e ala schina e laltre chel copre e sel circunda. Dala gibosita sua nasce la uena chilis laquale porta el sangue al core de laquale habiamo gia dicto. E da la parte sua concaua ne nasce unaltra chiamata porta o uero uena concaua e questa uena ha cinque rami : cusi como sono cinque penule del figato ne le quale entrano quisti cinque rami. E poi quando escono fuora del figato sono da poi otto de lequale doe sono molte piccole che male se possono discernere ma si le altre sei : De lequale una ua ala dextra parte del stomaco a nutrire la tunicha sua exteriore et maxime la parte inferiore : Laltra uena ua a la milza et e asai grande de laquale nel mezo del [folio 32 verso] suo transitio nasce un ramo che descende gioso a nutrire lintriglio e portali el sangue piu aquoso : Da poi quando questa uena sa proxima a la milza nasce un altro ramo el quale ua a nutrire la parte sinistra inferiore del stomaco da poi succede piu oltra e uasene ala concauita de la milza et iue se diuide in doi rami cio e inferiore e superiore : linferiore ramo descende gioso a nutrire el girbo quanto ala parte sua sinistra : el ramo superiore passa per le concauita de la milza e diuidise in doi altri rami di liquali uno ua a nutrire la parte superiore sinistra del stomaco, Laltro ua circa la bocha superiore del stomaco a portarli lhumore melenconicho per incitare lo appetito : Laltro ramo che rimane ua a la milza anutricarla.

La terza uena di queste sei sene ua al lato stancho e uaseno alo intestino recto a sucare se qualche humidita uiuatiua fusse rimasta ne le feze.

La quarta uena se ne ua a la superiore parte dritta del stomaco per nutrirla : La quinta uena ha doe parte una ua a nutrire la dritta parte del girbo, laltra parte se ne ua alo intestino colon a sucare quello che e rimasto ne le feze de humidita et anche a nutrirlo : et impero el girbo molto se congiunge cum lo intestino colon ne la parte dritta : La sexta uena sene ua alo intestino ieiuo et a lialtri intestini sottili a sugarli e nutrirli.

La figura del figato debba [folio 33 recto] essere lunare in modo de una luna quando e piu che meza. Questo membro ha quatro uirtu una atratiua per la quale atrahe el chilo a se : La seconda retentiua per laquale lo ritiene debito tempo acio che la terza uirtu che e digestiua lo conuerta in sangue : La quarta uirtu e expulsiua per laquale manda el sangue a tuti i membri a nutricarli : et cum esso sangue manda anche el spirito nutritiuo el quale se genera in esso figato.

Capitulum quartum. Tractatus tertii de anothomia chistis fellis.

El fele si ha uno uase como una cista doue se contiene lhumore collerico et e apicata a la meza penula del figato acio che depuri el sangue da lhumore collerico : e fu situato nel concauo e non nel gibo acio che piu facilmente potesse mandare la colera aglintestini a incitare la uirtu expulsiua che mandi fuora le feze.

Et ha doe parte cio e el collo che porta la collera e la uesica chela contiene : El collo a certa distantia rimane uno : E dapoi se diuide in doi rami uno ua amezo del figato ad attrahere la collera da esso. Laltro ramo descende alo intestino duodeno et questo se diuide anche in doi altri rami uno ua al fondo del stomaco a confortare la digestione e questo ramo e piccolo per che non bisognaua [folio 33 verso] andare tropo collera al stomaco per non incitare tropo la uirtu expulsiua del stomaco ad expellere, ma solo a confortare como e stato dicto : Et impero quilli che hano questo rame molto grande sono chiamati da medici infelici impero che sempre & al continuo regurgita su al stomaco la collera :

E per questo appare che questo membro ha colligantia cum el stomaco, intestini e figato e chel se nutrisse per certe uene et artharie che uadeno ad

esso cio e a la sua concauita : et anche peruengono a lui alcuni nerui a darli el sentimento : Onde ha anche colligantia cum el core e cum el cerebro.

Questo membro si e di figura oblonga cum una certa rotondita e la sua substantia e pelliculare cio e in modo de una pellicula facta per le utilita sopradicte.

Capitulum quintum de anothomia splenis et de eius uiuamentis.

Dal lato stanco sotto le coste mendose li e la milza laquale cum el suo concauo al lato del stomaco stanco se glie apozia : E quanto ala parte sua gibosa e alligata ala Schina et al panniculo dicto siphac mediante alcuni panniculi sutili

Et non fu posta cusi insu o uero in luocho alto como el figato ma piu ingioso : Et e di figura quadrangulare per che ha areimpire la concauita sinistra circumstante del stomaco che e di tale figura : ma e piu grossa ne la parte disopra et e piu sutile ne la parte inferiore a modo de una lingua.

E questo [folio 34 recto] membro e composto de una certe carne spongiosa acio che meglio receua lhumore grosso melenconico alquale finalmente e ordinata, Et anche e composta di uene et artharie molte, & de uno paniculo che linuolge Onde appare che la milza ha colligantia cum el figato, lintriglio, girbo, & cum el stomaco, cum le coste e cum el diafragma, et ha anche colligantia cum el core mediante certe artharie che uengono ad esse acio chel sangue grosso melenconico per el calore di queste artharie se sottigliasse e digerisse : Et anche acio che riscaldasse la sinistra parte del stomaco a laquale lui se apogia.

Fu facto questo membro per molte utilita : Prima acio chel mondificasse el sangue da lhumore melenconico el quale atrahe asi : Secondo fu facto a contra operare ala calidita del core e del figato : Tertio acio che excitasse lo appetito transmitendo lhumore melenconico a la bocha de esso stomaco.

*Capitulum sextum de anothomia girbi siue rethis cooperientis
stomacum & intestina.*

Appare uno certo panniculo chiamato el Girbo o uero la rethe el quale copre el stomaco da la parte dinanzi : e ne lhuomo tuti glintestini : e non ne lialtri animali : E questo fu facto ne lhuomo per che tra gialtri animali de equale quantita la uirtu digestiua piu debile ne lhuomo : et etiam per che glintestini suoi per la suttilita de la cute sono piu dispositi a [folio 34 verso] receuere li nocumenti exteriori : Et impero appare la utilita di questo membro per la quale fu principalmente facto : et e acio chel confortasse la uirtu digestiua nel stomaco e de glintestini reuerberando el caldo naturale ad essi : Onde narro Galieno de uno che fu uulnerato e cauato li fu el girbo e da poi che fu guarito non potete mai ben padre.

Et impero bisogno che fusse composto di tre sustantie cio e prima de doi panniculi subtili acio che continesse gialtri membri et etiam per che douea essere ligiero e che se potesse dilatare : et anche fu spesso acio che reuerberasse piu la calidita ali membri predicti : Secondo e composto de una assungia seposa la quale hauesse ariscaldare essendo la natura de lasongia molto propinqua al caldo : Tertio e composto di certe artharie e uene lequale molto riscaldano.

Et per questo appare chel girbo ha colligantia cum el stomaco cum la milza e cum glintestini, Et maxime cum lo intestino colon cum liquali lui si termina cooperendoli : Et etia ha colligantia cum li membri da liquali

ha origine : onde nasce da uno certo panniculo carnosio da la schina tra el diafragma per che a questo panniculo seglie terminano do extremita del panniculo chiamato siphac del quale poi noi diremo : Lequale extremita compogono el girbo : Et etiam per che iue glie una uena grande et etiam artharia [folio 35 recto] de lequale apresso el stomaco nascono certe uene et artharie picole lequale componeno el girbo : Ha etiam colligantia cum lintriglio dal quale nasce la sua songia seposa laquale reimpie le sue uacuita.

Per insino adoncha qui habiamo ueduto la anothomia del girbo, del stomaco, de gl'intestini, de lintriglio, del figato, del fele, e de la milza andiamo mo a gli altri membri di questa terza casa.

Capitulum septimum de anothomia membrorum urine scilicet renum & uesice et aliorum membrorum deseruentium eis.

Vediamo la anothomia dele rene. Onde tu uederai che da la uena chilis che nasce dal gibo del figato se fa uno ramo grande che descende gioso a le parte inferiore, e quando questo ramo e indritto de lerene se diuide in doi altri rami di liquali uno ua al rognone dritto e laltro al rognone stanco cio e a le sue concauita e chiamase uene emulgente : E gliorificii di queste doe uene non sono indritto uno dilaltro ma uno piu elto et e quello del rognone dritto e laltro piu basso cio e quello che ua al rognone stanco : Et questo fu perche el rognone dritto si e piu de sopra per che el rognone dritto e piu caldo cha el stanco, e de natura del caldo e distare disopra benche a le uolte acada chel rognone stanco sia disopra al dritto et alhora el rognone stanco uira essere piu caldo che el dritto : ben che questo sia [folio 35 verso] rare uolte.

Queste uene deportano la aquosita del sangue che e inutile al nutrimento del corpo a le rene et consequenter ala uesica : laquale esce poi fuora per urina : E per che cum questa aquosita e mescolato anche del sangue impero bisogno fare a la natura che el se colasse ne le rene in modo chel sangue mescolato cum questa aquosita rimanesse, e laquosita sola pasasse ala uesica : et impero se tu scindi el rogne ne la parte gibosa per lo longo per insino ala concauita tu uederai uno panniculo como uno panno raro per el quale puo passare la aquosita ma el sangue non impero quilli che hano aperto questo panniculo o uero colatorio orinano sangue. E questo panniculo si genera da la uena emulgente dicta laquale intrando ne la concauita del rognone se rariffica in modo de uno colatorio.

E bisognorno essere dui rognoni e non uno per che era molta quantita daquosita laquale uno solo rognone non haueria potuto atrahere sel non fusse stato molto grande e non se seria posuto debitamente situare sel non hauesse facto qualche eminentia in quello luoco che seria stato molte deforme.

Quisti rognoni sono piccoli in comparatione de li altri membri interiori e sono de una figura alquanto rotonda acio che fusseno capaci di maggiore quantita, et etiam che fusse piu tuto da li nocumenti extrinseci ; E furno etiam alquanto longhi acio che li suoi oreficii cio e el superiore doue entra [folio 36 recto] laquosita e loreificio inferiore doue esce haueseno migliore distinctione : a loreificio di sotto segli continua uno porro chiamato Uritides cioe che porta la urina da le rene a la uesica : Onde sono dui porri uritides como sono doi rognoni : Et in quisti rognoni ale uolte se genera la preda de molte harenule per la calidita de le rene la quale desicca certa humidita fleumatica laquale se genera nel stomaco per indigestione, e poi sene ua al figato, et tandem se ne uiene ale rene, et iue per la calidita de esse rene

se conuerte in harenule et tandem se conuerte in preda : laquale poi si discerne dala preda generata ne la uesica per che la preda de le rene e rossa e quella de la uesica e bianca. Li homini adoncha che hano fredo el stomaco e calde le rene sono disposti ala generatione de la preda et maxime hauendo li meati de lurina stricti.

Leuate adoncha le rene e ueduti i porri uritides tu uederai che terminano al mezo de la uesicha e non forano la uesicha ex directo cum uno bucho grande ma cum piu busitti piccoli et obliqui facti tra una tunica e laltra de la uesica o uero tra el cooptorio e la tunica e non uno indritto de laltro, e questo fu acio che quando la uesica fusse piena de urina ritornasse la urina indrieto ale rene, anzi quanto la uesica e piu piena de urina tanto piu se chiudeno dicti buchi.

La uesica e composta de doe tuniche quanto al suo fundo ma quanto al [folio 36 verso] suo collo e composta de carne e musculo Item e composta de nerui e de uene e de artharie ad atrahere laquosita dale rene et consequenter ad expellerla fuora per la uena.

E per questo appare che tuti quisti membri dicti cioe uene emulgente rognoni porri uritides e la uesica sono facti de la natura a mondificare el sangue che de nutrire el corpo de la predicta aquosita e mandarla fuora per urina.

Et impero li rognoni furno de sustantia e carne dura acio non fusse mordicata et corrosa de lacuita de lurina e da alcuni humori acuti che molte uolte se mescola cum essa urina.

Questi rognoni hebbeno dui paniculi uno che li copre e questo li da el sentimento, e laltro chel liga e suspende a la schina et anche questo li da el sentire : e ciascuno di questi doi panniculi e composto de uno certo neruo che nasce da la nucha de li spondili de la schina in luocho chiamato alchatim che e luocho a lo indritto de le rene et etiam e composto de uno certo ligamento che nasce da quilli medesimi spondili.

E per questo appare che hano colligantia cum el cerebro e la nucha et cum la schina mediante li nerui di li predicti panniculi, et hanno colligantia cum el core mediante certe artharie che nascono da lartharia adorthi e cum el figato mediante le uene emulgente, e [folio 37 recto] cum la uesica mediante li porri uritide liquali sono certi canili stricti per liquali passa la aquosita urinale da le rene a la uesica como e stato dicto, E questa uesica ha una grande concauita laquale e neruosa et el suo collo e carnoso e muscoloso acio che quando bisogna lhuomo expella la urina e quando bisogna lui la ritengha et congiongese el collo de la uesica cum la uirga ne li maschii, nel quale collo insieme cum la uirga e uno bucho per loquale se urina : ma ne le femine lextrimita del collo de la uesica se termina apresso a dua dita al ofificio de uulua : et el collo de la uesica ne li maschii e piu longo che ne le done.

E per questo appare che sel se incide la uesica nel collo se puo consolidare ma se si taglia nel fondo non si puo saldare, per che el collo e muscoloso e carnoso, et el fonde da la uesica e neruoso.

Et el collo de la uesica ne li homini ha tre tortuosita, ne le quale se ritiene lurina acio che facilmente non esca fuori senza uolunta de lhuomo ma ne le femine non ha sino una tortuosita, et el collo ne le femine e piu largo che ne li maschii : Et el fondo de la uesica e composto de doe tuniche como e stato dicto, e la tunica interiore e doe uolte piu grossa che la exteriore per che immediate tocha la urina.

A la uesica peruengono nerui da la nucha et anche le uene da la uena chilis et etiam certe artharie da la artharia adhorthi. Et nel collo suo e solo uno [folio 37 verso] musculo che circunda esso collo del quale la utilita e a retinere la urina secondo el bisogno e la uolunta de lhuomo, E quando lhuomo

uole urinare se relassa quello musculo : et alhora li muscoli del uentre de liquali diremo constringeno la uesica e mediante la uirtu expulsiua mandano fuora lurina.

Tractatus quartus de anothomia membrorum generationis capitulum primum, de anothomia matricis et uasorum spermaticorum in mulieribus.

Veduto la anothomia de tri membri principali e signori li quali cum li soi ministri sono producti da la natura a conseruare lo indiuiduo poniamo adesso la anothomia del quarto membro principale el quale e facto a conseruare la spetie. Et benche anche noi non habiamo fornito la anothomia del domicilio del terzo membro principale per che in uno medesimo domicilio quasi sono locati dicti membri cum li suoi ministri Diciamo adoncha che i membri de la generatione in alcune cose conuenene ne li maschii e ne le femine : prima quanto a la origine per nascono circa le rene in questo modo che li uasi che sono ne la parte sinistra e li uasi che sono ne la parte dritta nascono desopra de le rene, cio e le loro uene da la uena chilis e le lore artharie da lartharia adorthi Onde appare per questo che li uasi spermatici ne li maschii e ne le femine sono decusi da el core e da el figato e questa e la seconda conuenientia.

Ma etiam sono differenti per che ne le femine questi uasi se terminano a la matrice [fol. 38 recto] nel luocho exteriori doue sono li loro te testiculo anzi propriamente parlando non sono ueramente testicoli como ne gli maschii anzi sono como testicoli de lepore Onde fuora de la matrice se riuolgono e se contexeno e le concauita di quella textura se reimpieno di certe carne minute glandose : E sono facti ne le femine acio che generino una certa humidita saliuale laquale e cagione de la delectatione de cohito ne la femina.

Da poi quisti uasi spermatici penetrano la matrice per insino a la concauita e li suoi orificii di quisti uasi ne la concauita de la matrice se chiamano cotilidoni cio e legamenti per che mediante quilli sta ligata la creatura ala matrice : e per questi orificii uene el sangue mestruo ala femina : Et alcuni di questi uasi peruengono a la bocha de la matrice a portar li la humidita saliuale gia dicto : Et da queste uene ramificate nascono doe uene da ciascun lato cio e una che penetra nel panniculo chiamato mirach et ascendeno per insina che peruengono ale mamille a deportare el sangue a quelle : Et nota che quanto piu ascendeno tanto piu se acostano a la cute di fuora : et sono piu manifeste : ma nel mirach sono piu oculte e questo e contrario ne la porcha o altri animali che hano le mamille nel mirach : Queste uene nascono da la matrice e se manifestano nel mirach doue sono poste le mamille.

E dappoi queste uene ascende dal [folio 38 verso] profondo del pecto indrito al pomo granato una certe uena laquale uene ale mamille a cuocere el sangue che se de conuertire in lacto e non appare senon una uena.

El luocho de la matrice e che le situata ne la concauita del luocho chiamato alchatim, laquale concauita e circundata da certi spondili dela schina per insino a la cauda da la parte de drieto, ma da la parte dinanzi e circundata da la parte che se chiama petenechio : onde la matrice e locata immediate tra lo intestino recto el quale e como colcitra sua da la parte posteriore e fra la uesica da la parte dinanzi et el collo de la uesica e piu eminente cha el collo de la matrice benche la concauita de la matrice sia piu profonda che la concauita de la uesica : et la matrice e posta nel mezo preciso tra el lato dritto e el stanco.

Questa matrice ha colligantia quasi cum tuti li membri superi cio cum

el core mediante certe artharie e cum el figato mediante certe uene, e cum el cerebro mediante molti nerui, e cum el stomaco mediante nerui e uene : et ha colligantia cum li membri di mezo cio e cum el diafragma le rene, et mirach : per che mediante quisti e alligata ali predicti ha maxime colligantia cum le mamille como e stato dicto : Ha etiam colligantia cum li membri inferiori cio e cum la uesica mediante el suo collo : et e similiter cum lo intestino colon.

Et e alligata a le [folio 39 recto] anche mediante alcuni ligamenti grossi e forti li quali apresso de la matrice sono larghi e grossi et apresso le anche sono sottili como corne che sono nel capo de gli animali et impero sono chiamati corni de la matrice.

La figura sua e quadrangulare cum certa rotondita : et ha el collo inferiore longo et hebbe questa figura acio che meglio se potesseno distinguere le cellule o uero camerette che sono ne la sua concauita e sono septe tre ne la parte dritta e tre ne la parte stanca e una ne la sumita o uero mezo e queste celule sono certe concauita ne la matrice ne lequale el sperma cum el sangue mestruo se possano continere et coagulare et consequenter alligarsi a li oreficii de le uene.

La quantita de la matrice fu mediocre secondo la quantita de la uesica, ma e maggiore in una femina che in laltra per che la femina che fa figlioli ha maggiore matrice che la sterile et similiter la femina che e usa al cohito lha maggiore che la uergene et similiter la matrice de la giouene e maggiore che quella de la puta e de la uechia e per altre cagione narrate da medici puo essere questa diuersita.

La sua sustantia e neruosa e pelliculosa acio che se possa dillatare a continere la creatura : et e molto spessa e grossa.

Le parte exteriore de la matrice sono queste cio e li lati difuori aliquali sono alligati li testicoli e anche sono li uasi seminarii e [folio 39 verso] le sue corne di liquali tuti habiamo dicto : et el suo collo del quale lextremita se chiama uulua : e questo collo e longo quanto e uno palmo como e la uirga de lhuomo et e lato e dillatabile : et impero pelliculoso : Et ha le rughe o uero cresphe in modo de sangue sughe acio che la uirga de lhuomo nela confricatione del cohito se le induca tintalatione e consequenter dolceza : Et ne lextremita di questa uulua sono doe pellicole che se lieuano e deprimeno sopra el dicto oreificio acio che prohibiscano lo introito de laiere o di qualche cosa extrinsecha nel collo de la matrice o uero uesica como la uirga de lhuomo e custodita da la pellicula del preputio.

E la bocha de la matrice e molto neruosa facta in modo de una bocha de uno cagnolo nouamente nato o uero meglio a modo de una tench uechia : et e ualata de uno uele sottile ne le uergene e ne le uiolate se rompe et impero se sanguina.

Facto e adoncha questo membro da la natura per la conceptione : et ne lhuomo fu facto anche acio che mondificasse tuto el corpo de la femina dal superfluo sangue indigesto el quale se genera in essa per la sua frigidita, e nel maschio non e cusi : ma li altri animali non hano questo fluxo mestruale per che tale superfluita che se genera in loro se conuerte in pelle in pili in unghie in rostri e penne e simili membri di quali lhuomo e priuato.

[folio 40 recto] *Capitulum secundum de anothomia uasorum spermaticorum et testiculorum in uiris seu masculis*

Dicto di uasi spermatici e testicoli de le femine diciamo di quilli di li maschii : Onde da sapere che li uasi spermatici sono de doe manerie, alcuni sono uasi che preparano el sperma e quisti descendeno da luochi predicti

ali testicoli & circa la parte superiore de essi se inuolgeno intanto che fano in modo de uno sacho o uero de una bursa e questi non intrano la sustantia dili testicoli e questi sono uenosi e neruosi

Alcuni altri uasi sono dilatorii liquali portano el sperma preparato ne li altri uasi dicti a li testicoli e questi se continuano cum li predicti et sono piu neruosi : e quanto uano piu ascendendo da li testicoli sono tanto piu neruosi et ascendeno per insino a losso del petenechio : et alhora se profundano dentro appresso el collo de la uesica e finaliter procedeno al meato de la uirga nel luocho che e nel bucho de losso del petenechio e per doe meati che sono iue mandano el sperma fora da li testicoli el quale fu preparato prima negli altri uasi e mandano quello sperma nel canale de la uirga e poi la uirga el manda fuori.

Et li testicoli ne lhuomo maschio sono di fuera e non detro como e ne le femine onde li uasi spermatici del maschio non sono terminati dentro dal mirach o uero dentro dal corpo ma escono fuera e se copulano a li [folio 40 verso] testicoli como a doi suspensorii o uero contrapeso, Et quisti uasi sono cooperti & uelati de uno panniculo chiamato didimo el quale nasce del paniculo siphach del quale poi noi diremo, e questo didimo se ha uno oreficio chiuso ne la fine de dicti uasi et in processo se dillata e tanto procede dilatandosi che infine di quello se dillatta ala quantita de li testicoli et iue fa una bursa la quale se chiama borsa di testicoli : onde appare che questo didimo fu facto a continere e custodire li testicoli : et li uasi spermatici che peruengono ad essi.

Et in questa borsa glie sono posti doi testicoli facti de sustantia glandosa rotondi facti secondo li medici a generare e produrre el sperma per che benche el sia preparato ne li uasi spermatici tamen non receue in essi la debita forma specifica ma da li testicoli. Et secondo el philosopho Aristotile el sperma perfectamente se produce ne li uasi spermatici e che li testicoli furno facti como doi contrapesi a retinere i uasi aper ne la projectione del sperma.

Capitulum tertium de anothomia uirgae et de musculis ani: & de quinque uenis emoroydalibus.

Ultimo e la uirga continuata cum lo collo de la uesica carnosio e e continuata cum esso cum molti ligamenti e corde lequale nascono da losso del petenechio insieme cum certi nerui [folio 41 recto] che nascono da la nucha : et impero questo membro e molto sensibile et extensibile ; Et anche e continuata la uirga cum gran uene che nascono dal ramo de la uena che descende ale parte inferiore et similiter e continuata cum grande artharie lequale nascono da quella artharia laquale se bifurca ale doe anche : onde a la lingua et ala uirga uengono maggiore uene et arthariae che a nesuno altro membro a tanto pertanto : Et impero queste uene & artharie nel luocho chiamato peritoneon cio e tra loreificio del culo et el luocho di testicoli sono inuolute e sono molto grande : et iue e el principio de la uirga : Et per questo la uirga e tuta cauernosa e le sue cauernosita se reimpino de uentuosita laquale se genera in quelle artharie et alhora se driza la uirga : Onde se tu scindi per lo longo la uirga insino al suo canale et apparerano dui buchi predicti et etiam le sue cauernosita.

La quantita de la uirga o uero longheza sie duno palmo como e quello del collo de la matrice.

La sustantia de la uirga sie neruosa excepto la extremita sua che se chiama preputio.

Da poi a lextremita delo intestino recto chiamato anus tu trouerai certi musculi che apreno & asera o quello oreficio et similiter ne lextremita del

dicto oreificio li sono cinque uene terminato ad esso chiamate uene [folio 41 verso] emoroydale per lequale in alcuni homini a certi tempi esce di molto sangue.

Capitulum quartum de anothomia mirach : quod est domicilium predictorum duorum membrorum principalium.

Dapoi che noi habiamo ueduto de doi membri principali uno che serue al nutrimento di li membri a conseruare el corpo e laltro a conseruare la spetie : et anche de li suoi ministri resta a uedere del suo domicilio el quale e comune a tuti quilli el quale se chiama mirach.

Questo mirach o uero questo domicilio si e composto de cinque parte cio e cute pinguedine uno certo panniculo carnosio e certi musculi cum le sue corde et el siphac : de tute queste cinque parte se costituisce uno cooperculo et una casa ne laquale se contengono li membri predicti.

El questo tale domicilio fu posto di sotto da li altri per la ignobilita di membri che se contengono in esso : Onde contiene alcuni membri deputati a purgare le feçe e le superfluita lequale essende graue descendeno a le parte inferiore.

Questo domicilio non potette essere ossuoso ma fu carnosio et pelliculoso acio che secondo li bisogni se potesse dillatare et intumescere como ne la femina pregnante o uero in colui che ha pigliato troppo cibo o uero ne lo ydropico o per qualche altra cagione bisognasse infiare el uentre, sel fusse ossuoso non se potria fare questo.

[folio 42 recto] La prima parte di questo mirach si e la cute de fuora circa laquale sono da considerare piu luochi : Uno si e corespondente ala bocha del stomaco che una cartilagine che copre quello e chiamasi pomo granato como e stato dicto.

Laltro luocho si e la parte che e sopra el stomaco sopra de lombelico circa a quatro dita.

El terzo luocho si e la parte umbelicale cio e doue e lombelico cum el quale sta alligata la creatura nela matrice cum le uene de essa matrice : et impero ne le parte interiore de lombelico appare una certa uena che se continua cum esso, et passa per el gibo del figato e per questa uena se porta el sangue da le uene de la matrice al figato de la creatura et inquesto modo se nutrisse nel uentre de la matre : Ma questa uena quando lhuomo e nato se priua di sangue per che manca la sua operatione quale facea alhora : Et impero continuamente se ua diminuendo quella uena, onde ne li uechii appare molte minore che ne li gioueni : Et similiter cum questa uena descende una certa artharia a lombelico de la creatura laquale quando e ne lombelico descende gioso e uasene a lartharia adorthi apresso li spondili de le rene et di li fianchi e questa artharia simelmente se ua deleguando e continue appare minore como e stato dicto de la predicta uena, E questa artharia tu uederai exscarnando apresso lombelico et apparerati in forma de uno neruo o de una corda [folio 42 verso] El quarto luocho se chiama sumen, di sotto da lo imbilico quatro dita et e una parte ne laquale se terminano alcune uene ala cute per le quale la creatura nel uentre de la matre manda fuora le sue aquosita : e queste uene e questa tale parte si e piu manifesta ne li puti che non sono nati che ne li perfecti perche essendo queste uene frustrate da la sua operatione se uadeno annullande.

El quinto luocho si e el petenechio doue sono li membri genitali.

Da poi anche tu hai a considerare le parte laterale cioe li li fianchi e li ypocondrii uno da la parte dritto sotto el quale sta el figato e laltro da la parte mancho doue e locata la milza.

Dapoi la cute apparerati incontinenti la pinguedine la quale e molto piu grande nel porcho che ne lhuomo.

Dapoi et tertio te apparera uno panniculo el quale e composto de carne e nerui.

Quarto di sotto a questo panniculo li sono etiam octo muscoli di liquali doi sono longitudinali che protendono per el longo dal clipeo de la bocha del stomacho insino a lossa del petenechio, e quisti muscoli non hano gran corde senon ligamentale, Quattro altri sono transuersali dui superiori e dui inferiori: Li superiori nascono da la parte di sopra a presso le coste et terminano a certe corde circa le ossa del petenechio in questo modo che la corda [folio 43 recto] dritta ua alingioso al musculo che uiene da la parte sinistra, et la corda stanca ua gioso al musculo che uiene da la parte dritta: Onde le corde se incrociano ne la parte inferiore. Li altri dui muscoli transuersali sono inferiori per che comentiano da le ossa del petenechio et de le anche e se terminano a certe corde in questo medesimo modo che la corda dritta ua al musculo sinistro e la sinistra ua al musculo dritto, e le corde se incrociano como e stato dicto.

Doi altri sono latitudinali cusi dicti per che li fili di liquali se componeno protendendeno secondo el lato: Et uno di quisti muscoli e dal lato dritto e laltro del lato stancho, e sono piu manifesti et anche la sua origine apresso de la schina uerso la parte superiore: e quisti muscoli latitudinali insieme cum li longitudinali se intersecano ne li anguli dritti.

La utilita di quisti muscoli sie prima acio che deffendeseno li membri interiori da li nocumenti extrinseci, et anche che li riscaldaseno reuerberando la loro calidita a le parte dentro. La seconda e acio che aiutino ad expellere le superfluita dal pecto e le superfluita dele feze et etiam ad expellere la creatura fuora, e queste sono utilita comune a quisti octo muscoli: Ma piu particolarmente parlando Li muscoli [folio 43 verso] longitudinali sono facti primo ad atrahere, secondo ad expellere, onde expelleno contrahendo li suoi uili liquali contratti comprimeno glintestini uerso el diafragma como se fosseno tra doe mane che li comprimeseno e per questo modo expelleno fuora le feze: Et per che glintestini hano bisogno maxime di queste doe operatione cio e de atrahere et expellere impero quisti muscoli furno grandi.

Ma li muscoli latitudinali sono solo facti ad expellere: & impero sono piu apresso glintestini et fano questa expulsione comprimendo la parte da laquale deno expellere: Et per che la expulsione se fa da suso ingioso impero furno locati piu tosto ne le parte superiore che inferiore.

Li transuersali furno facti a retinere e questo fano mediante li suoi uili transuersali, E questo bisogno fare la natura acio che le superfluita gio descese non reascendeseno impero fece li dui transuersali superiori et anche hebbe intentione che le feze non descendeseno molto ueloce mente anzi se retignisseno tanto che el figato le potesse bene esucarle como e stato dicto impero fece altri du imuscoli transuersali inferiori: liquali sono minori che li superiori per che maggiore fu intentione de la natura a fare che le feze non reascendeseno cha che uelocemente non descendeseno.

La quinta parte de questo mirach [folio 44 recto] si e uno panniculo suttilissimo e molto duro chiamato siphac et fu facto aciochel prohibisse che li muscoli dicti non comprimeseno i membri naturali e per questo fu neruoso acio che se possa dillatere e constringere quando quilli membri se dillateno e se constringeno. E fu sutile acio che quello non li agrauasse. Et fu duro acio che facilmente el non se rompesse per che quando se rompe accade quella passione che si chiama crepatura.

E fu facto etiam questo panniculo acio che el lighe glintestini a la schina et acio che tuti li panniculi de li altri membri interiori che se contengono

in esso habiano origine da quello: Et etiam aciochel prohibisca che glintestini non se rompano quando se infiano de uentosita, e perquesto appare la anothomia de tuto el mirach el quale e domicilio de tuti li altri membri gia dicti.

*Tractatus quintus de anothomia partium extremarum & ossium
Capitulum primum de anothomia ossium et neruorum quae sunt
a collo usque ad caudam.*

Expediti li quatro membri principali cum li loro ministri e cum li loro domicilii. Vediamo mo la anothomia de le parte extreme cio e braza cum le mano, et de le cosse cum li piedi ma prima uederemo de le ossa nerui e nucha comentando dal collo per infino a la cauda.

Diciamo adonca che el collo fu facto per el pulmone e per la sua cana ne li animali che respirano: et inquesto collo sono septe [folio 44 verso] ossa chiamati spondili, et sono piu sottili de glialtri inferiori per che sono sustentati da quilli: Et benche siano sottili pur sono molto duri e firmamente congionti acio che non si dislacaseno, et anche che non receuesseno nouemento da le cose extrinsece. Et quisti spondili benche siano piu sottili de li altri pur hano el bucho maggiore per che la nucha e piu grossa nel collo che in alcuna pare di li altri spondili e questo fu per che iue ha la sua origine.

Dapoi quisti septe spondili li sono altri spondili che se chiamano spondili de le coste e sono dodece secondo el numero de le coste de lequale septe sono uere e cinque mendose.

Da poi sono li spondili de le rene liquali sono cinque, e sono molto grossi e grandi per che sono fondamento e sustentaculo de li altri spondili.

Da poi sono alcuni altri spondili liquali sono ne plichatura che e da la schina a la cauda e sono tri minori di li predicti per che se doueano congiungere cum li spondili de la cauda liquali sono piccoli.

Ultimo sono li spondili de la cauda et quiui sono molte differentie de buchi per liquali passano li nerui, e queste tale diuersitate se uedeno meglio nel corpo cotto o uero perfectamente esiccato.

Et in ciascuno spondile e posta la nucha la quale e una medula simile ala substantia del cerebro senon che e piu uiscosa e piu salda et ha [folio 45 recto] origine da esso cerebro, el quale essendo diuise in doe parte cio e ne la parte dritta e ne la parte mancha impero ne la superficie di questa nucha appare uno filo che la diuide per mezo cio e la parte dritta da la parte stanca: E fu facta da la natura acio desse el sentire e el mouere a tuto el corpo dal capo ingio onde la nucha e ditta uicaria del cerebro.

Da la nucha in ciascaduno spondile nasce uno pare de nerui che uanno a dare el sentire e el mouere a certi e uarii membri. E per che li spondili sono intuto trenta impero sono trenta para de nerui secondo el numero di li spondili: et poi dala cauda ne nasce un altro pare de nerui onde sono intuto trentauno pare de nerui oltra quelli sei para ditti disopra che nascono dal cerebro.

Capitulum secundum de anothomia brachiorum et manuum.

Le braze e le mano sono composti de cute pinguedine, carne, uene, corde, ligamenti, ossa.

Tu uederai una uena che penetra per sotto la lasina del brazo e procede per la parte domestica e uasene ala curuatura del brazo et appare ne la parte inferiore de gubito e chiamasi basilica e poi protende piu oltra

descendendo gioso a la mano ne la parte siluestra e uasene tra doi digiti cio e el digito piccolo chiamato auricolare et el suo proximo digito [folio 45 verso] chiamato annulare, e chiamasi questa uena iue sylen e coresponde ala basilica como suo ramo.

Vederai simelmente un altra uena che uiene per la parte domestica del brazo ne la parte superiore de gubito e chiamasi cephalica per che e uacua del capo et nasce da una uena che ascende al capo e questa uena piu oltra procede uerso la mano e uassene ne la siluestra parte tra e il dito grosso e lindice e chiamasi saluatella e corresponde a la cephalica.

Un altra uena uederai ne la curuatiua del brazo in mezo de le predictae como uno ramo continuato cum tute doe e chiamase uena media o uero uena comune.

Da poi le uene tu uederai di molti muscoli e molte corde grande e grosse. Li muscoli furno facti a dare el moto uoluntario al quale deseruono etiam esse corde.

Dapoi tu uederai le ossa et comentiendo ala spala tu uederai prima un osso chiamato spatula de simile figura como e una spatula de legno el quale e largo disotto acio che non impedischa el pecto e le coste, et e stricto di sopra acio che cum laltro osso che tu uederai chiamato aiutorio meglio se firme : et impero ne la extremita superiore di questa spatula glie una concauita superficiale rotonda acio che in esse sia situata la extrimita de lo aiutorio rotonda del quale el capo primo e rotondo locato ne la extremita de losso de la spatula poi nel mezo se obliqua uerso la domestica parte acio che nel plicare et [folio 46 recto] amplexare de le cose sia piu habile : Et lo extremo di questo aiutorio ha quasi doe eminentie per che se congionge cum dui ossi chiamati focilli, et in mezo de quelle parte eminente ha piu disopra una certa concauita ne laquale entra lextremita del focille inferiore laquale e facta a modo de uno instrumento da trare laqua acio che sia piu ferma la sua coniunctione et el focille inferiore e piu longo che el superiore per che linferiore sustenta el superiore : Ma tuti dui conuegono in questo che ne li extremi sono piu grossi che nel mezo per che da li extremi loro nascono ligamenti e iuncture, et nel mezo glie sono muscoli che suplisen a la loro sutilita : Et el focille superiore non procede dritamente como linferiore acio che sia cagione de plicare la mano et el brazo.

Dapoi questi do focilli glie la resetta de la mano ne la quale sono octo ossi in doe schiere cioe quatro per schiera : Dapoi sono le ossa del pectine de la mano perche e facta ala forma de uno pectine e sono quatro corrispondenti a quatro digiti per che al dito grosso non corresponde alcuno osso di questo pectine per che non e in schiera cum li altri digiti.

Dapoi sono le ossa de li cinque digiti, et hano tre ossi per digito che sono intuto quindice : Da poi sono le corde che uano ale iuncture et ultimo la carne laquale e molto piu ne la parte domestica, et da li lati ma pocha ne la parte siluestra per che plicandosi [folio 46 verso] ne la parte domestica non recceuesse lesione per la durezza de li ossi e che non accadesse uacuita alcuna dai lati e da poi li sono le onghie a coprire la cornosita che e ne lextremita de dicti digiti.

Capitulum tertium de anothomia cossarum tiliarum et pedum.

Vediamo mo ultimamente de la anothomia de le cosse, gambe e piedi. Diciamo adoncha che scorticando le cosse tu trouerai doe uene grande che sono ramificate dal troncho de la uena chilis che descende gioso el quale quando e nel fine de li spondili dele rene se diuide in doi rami uno

ua ala gamba dritta e laltro ala stancha et similiter se ramifica el troncho de lartharia adorthi che descende : e ciascuno di quisti doi rami in ciascuna gamba se diuide in doi altri rami uno descende per el dritto e per la domestica parte de la gamba et chiamas Saphena per che flobotomata e uacua dai membri naturali e genitali et appare questa uena sopra del genochio e sopra la cauchia del piede, e desotto nel calchagno et appare anche nel pectine del pede.

Un altro ramo se obliqua et intra apresso la iunctura de la scia¹ o del galbue¹ impero e chiamata siatica : ondo per la obliquatione chè fa circa queste iuncture flobotomata uale ne le sue passione : Et appare questa uena intuti i predicti [folio 47 recto] luochi como e dicto de la saphena.

Ne la parte siluestra ua escarnando e lieua su li musculi e le corde e uederai prima losso del petenechio sopra del quale sono fabricati li spondili de la schina et consequenter tuto el corpo ne la parte inferiore ha una concauita ne laquale e locata la extremita rotonda laquale extremita se chiama uertebro e nel mezo di quisti doi da la parte dentro lie uno certo ligamento e questa iunctura di questi doi ossi se chiama scia : et impero el dolore che uiene iui se chiama dolore sciatico.

Dapoi tu uederai losso grande de la cossa el quale e maggiore de tute le ossa che sono nel corpo per che sustentaculo de tuto el corpo : Et hebbe una grande concauita acio che fusse piu ligiero e che hauesse molta merolla. Et per che potesse meglio sustentare non lo fece dritto la natura ma ne la extremita fecelo pighato uerso la domestica parte : e nel mezo sie plicato e conuexo.

Dapoi questo osso nela iunctura del genochio sono dui ossi dicti focilli de la gamba ma uerso la parte dinanzi di quella iunctura glie uno osso chiamato patella facto in modo de una patella acio che la iunctura fusse piu forte : e questa iunctura e facta de ligamenti como fusse ligata per uno groppo Et el focille che e ne la parte domestica e maggiore e piu grosso per che ha piu a sustentar el peso [folio 47 verso] del corpo e quello de la parte siluestra e piu sutile e curto facto solo chel sia apogio del maggiore.

Da poi lie losso de la caichia cum el quale se congiongono li dicti focilli, et e losso del calcagno grosso quadrangulato sotto del quale e una cute grossa e callosa molto.

Da poi e uno osso facto in modo de una u nauicula quadrangulare alquanto longo.

Dapoi e la rasetta del pede composto de tri ossi e non de octo como fu la resetta de la mano perche el pede douea stare firmo e non mouersi a retinire qualche cosa como la mano.

Da poi li e el pectine composto da cinque ossi per che el dito grosso e inschiera cum li altri.

Da poi sono le ossa dili dighi che sono quatuordice cioe dui al dito grosso e tri per ciascaduno de li altri. Da poi sono certi musculi e molte corde a mouere contrahendo e dillatando i dighi et ultimo li sono le onghie che copreno la carnosita de li cime de li dighi como e stato dicto di dighi de le mane. E cussi a laude de dio habiamo compiuto quello che era nostra intentione e quello che dal principio noi prometessimo di narrare.

¹ These four words are very indistinct. The last is half erased and *scia* is written *sia*.

THE BLESSING OF CRAMP-RINGS

A CHAPTER IN THE HISTORY OF THE TREATMENT OF EPILEPSY

BY RAYMOND CRAWFURD

THE origin of this ceremony of blessing rings, by the kings and queens of England, for the cure of epilepsy and other spasmodic disorders, appears to be well attested by the evidence of many contemporary records. All alike refer it back to Edward the Confessor, or, to be more exact, to the ring which was one of the sacred relics in the shrine of the Confessor in his abbey of Westminster. Caxton, in the *Golden Legend*,¹ tells the tale of this wonderful ring, as follows :

‘ When the blessed King Edward had lived many years, and was fallen into great age, it happened he came riding by a church in Essex called Havering, which was at that time in hallowing, and should be dedicated in the honour of our Lord and S. John the Evangelist ; wherefore the king for great devotion lighted down and tarried, while the church was in hallowing. And in the time of procession, a fair old man came to the king and demanded of him alms in the worship of God and S. John the Evangelist. Then the king found nothing ready to give, ne his almoner was not present, but he took off the ring from his finger and gave it to the poor man, whom the poor man thanked and departed. And within certain years after, two pilgrims of England went into the holy land to visit holy places there, and as they had lost their way and were gone from their fellowship, and the night approached, and they sorrowed greatly as they that wist not whither to go, and dreaded sore to be perished among wild beasts ; at the last they saw a fair company of men arrayed in white clothing, with two lights borne afore them, and behind them there came a fair ancient man with white hair for age. Then these pilgrims thought to follow the light and drew nigh. Then the old man asked them what they were, and of what region, and they answered that they were pilgrims of England, and had lost their fellowship and way also. Then this old man comforted them goodly, and brought them into a fair city where was a fair

¹ Life of St. Edward.

cenacle honestly arrayed with all manner of dainties, and when they had well refreshed them and rested there all night, on the morn this fair old man went with them, and brought them in the right way again. And he was glad to hear them talk of the welfare and holiness of their king S. Edward. And when he should depart from them, then he told them what he was and said: I am John the Evangelist, and say ye unto Edward your king that I greet him right well, by the token that he gave to me this ring with his own hands at the hallowing of my church, which ring ye shall deliver to him again. And say ye to him that he dispose his goods, for within six months he shall be in the joy of heaven with me, where he shall have his reward for his chastity and for his good living. . . . And when he had delivered to them the ring he departed from them suddenly. And soon after they came home and did their message to the king, and delivered to him the ring, and said that S. John the Evangelist sent it to him.'

Shortly after this Edward departed this life, and was laid in his abbey of Westminster, where the usual abundant harvest of miraculous cures was enacted at his shrine. In the above story we have also the explanation of one synonym of epilepsy, the 'morbus sancti Iohannis'.

The further history of the ring may be gleaned from several sources, but notably from a MS. by one Richard Sporley, a monk of the abbey, entitled, 'De fundacione ecclesie Westm', dated A.D. 1450, and now in the British Museum.¹

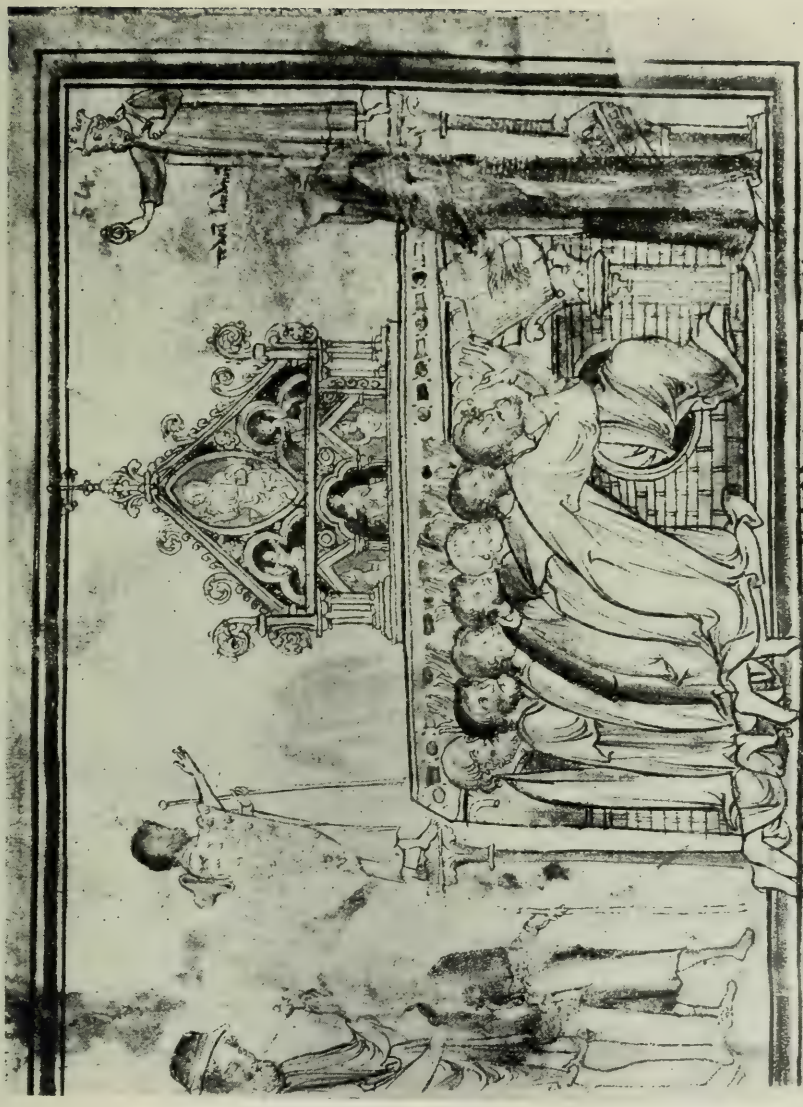
St. Edward's ring was deposited with his corpse in the tomb in A.D. 1066. He was translated at midnight of October 13, 1163, when his body was found to be incorrupt. Abbot Lawrence took the robes from the body and made them into three copes, and gave the ring as a sacred relic to the Abbey:

'Dompnus Laurentius quondam abbas huius loci . . . sed et annulo eiusdem (Sancti Edwardi) quem Sancto Iohanni quondam tradidit, quem et ipse de paradiso remisit, elapsis annis duobus et dimidio, postea in nocte translationis de digito regis tulit, et pro miraculo in loco isto custodiri iussit.'

The story of the ring is also depicted in the miniatures of a beautiful illuminated Norman-French MS. Life of St. Edward the King, dating from the thirteenth century, and now in the University Library at Cambridge.² The single miniature reproduced here (Plate xxxix) shows seven blind men, restored to

¹ British Museum MS. Cotton. Claud. A. viii, ff. 32, 33, and *Archaeol. Journal*, London, June, 1864.

² MS. Ee. iii. 59.



...e puet la fame estre cene. Quant de une redoyer

PLATE XXXIX. MIRACLES AT THE TOMB OF
EDWARD THE CONFESSOR
XIIIth Century

sight, kneeling at the shrine, while a priest reads the *Te Deum*. At the sides of the shrine are figures on pillars of St. John as the palmer (left), and St. Edward with his ring (right). No cure of epilepsy, so-called cramp, is depicted among the many miraculous cures recorded in the MS. The earliest extant records of the use of the ring for this purpose date from the reign of Edward II.

Anstis¹ cites the following entry from the last chapter of the *Constitutions of the Household of Edward II*: 'Item le Roi doit offer de certain le jour de grant vendredi a crouce. v s. queux il est acustumez recevoir devers lui a la mene le chapelein affair ent anulx a donner pur medicine az divers gentz': the language, however, of the entry leaves little room to doubt that the custom was already an established one. At his coronation, too, Edward II offered a pound of gold wrought into a figure representing St. Edward holding a ring, and a mark of gold, or eight ounces, worked into the figure of a pilgrim putting forth his hand to receive the ring: and the presumption is that this gold was to be converted into cramp-rings.

We have detailed accounts of the manner of this ceremony of hallowing cramp-rings dating from early Tudor times, and there is sufficient evidence in the brief notices of earlier date to show that the ceremonial observed by the Plantagenet kings was essentially similar. On Good Friday, when the king went to adore the cross, he used to make an offering of money, which was redeemed by a sum of equivalent value: the money so received was converted into rings, which were subsequently hallowed by the king. In Tudor times the hallowing of the rings took place on Good Friday, so that the offering of the money must have been made at some previous time, or this part of the ritual may have actually become obsolete. The change of custom was effected some time between 9 Edward IV (1470-1) and 13 Henry VIII (1521-2), and was probably therefore the work of Henry VII, who, as we know, materially altered the kindred ceremonial of Touching for the Evil.

A MS. copy of the Orders of the King of England's Household, 13 Henry VIII, preserved in the Bibliothèque Nationale at Paris,² contains, 'The Order of the Kynge, on Good Friday, touching the cominge to Service, Hallowinge of the Crampe Rings, and Offeringe and Creeping to the Crosse'. It is quoted

¹ *History of the Garter*, vol. i.

² MS. 9986.

in extenso in the Northumberland Household Book,¹ and also by Mansell in his *Monumenta Ritualia*.² It runs as follows :

‘ First the king to come to the closett or to the chappell with the lords and noblemen wayting on him, without any sword to bee borne before him on that day, and there to tarry in his travers till the bishop and deane have brought forth the crucifix out of the vestry (the almoner reading the service of the cramp rings) layd upon a cushion before the high altar, and then the huishers shall lay a carpet before y^t for ye king to creepe to the crosse upon : and y^t done, there shall be a fourme set upon the carpet before the crucifix, and a cushion layd before it for the king to kneele on ; and the Master of the jewell house shal be ther ready with the crampe rings in a basin or basins of silver : the king shall kneele upon the sayd cushion before the fourme, and then must the clerke of the closett bee ready with the booke conteyninge ye service of the hallowing of the said rings, and the almoner must kneel upon the right hand of the king, holding of the sayd booke, and when y^t is done the king shall rise and go to the high altar, where an huisher must be ready with a cushion to lay for his grace to kneele upon, and the greatest Lord or Lords being then present shall take the basin or basins with the rings and bear them after the king, and then deliver them to the king to offer ; and this done the queen shall come down out of her closett or travers into the chappell with ladies and gentlewomen wayters on her, and creepe to the crosse ; and that done she shall returne againe into her closett or travers, and then the ladies shall come downe and creepe to the crosse, and when they have done, the Lords and noblemen shall in likewise.’

Creeping to the Cross seems to have been practised in noble households as well as in that of the king. The following entry is found in the Northumberland Household Book³ (*temp.* Henry VIII) :

‘ Item my Lord useth and accustometh yerely when his Lordship is at home to cause to be delyveride for the Offerings of my Lordis Sone and Heire the Lord Percy upon the said Good Friday When he crepith the Crosse *ijd.* Ande for every of my Yonge Maisters my Lords Yonger Sonnes after *jd.* to every of them for their Offerings when they Crepe the Cross the said Good Friday *iiijd.*’

Many of the entries in the accounts of the Plantagenet kings show that the homage was paid to the Gneyth Cross. This cross was held in great veneration, and, according to tradition, was made of wood from the true Cross presented by a pilgrim to Richard Cœur de Lion : no satisfactory explanation of its name is forth-

¹ p. 36.

² Vol. iii.

³ p. 334.

coming. It seems to have been transferred from place to place. Under Edward I we find it in the royal chapel of the Priory of Plympton : under Edward II in the royal chapel within the Tower : under Edward III in the private chapel of the royal Manor of Clipstone, and later in the same reign in St. George's Chapel at Windsor, where it was in the time of Henry VII. The purpose of the ceremony is set forth in a Proclamation of February 26, 30 Henry VIII, now in the possession of the Society of Antiquaries: 'On Good Friday it shall be declared howe creepyng of the Crosse signifyeth an humblynge of ourselfe to Christe before the Crosse, and the kyssyng of it a memorie of our redemption made upon the Crosse.' When Convocation, in A. D. 1536, abolished some of the old ceremonies, on the ground that they were superstitious, this of Creeping to the Cross was retained as a laudable and edifying custom.

The following records, taken from the Household Books and Account Rolls of the times, serve to establish the continuity of the ceremonial subsequent to its first mention in the time of Edward II.

In the Eleemosyna Roll of 9 Edward III ¹ occurs the following entry :

'In oblacione domini Regis ad crucem de Gneythe die parasceues in capella sua, infra mannerium suum de Clipstone, in precium duorum florencium de Florencia, xiiii die Aprilis, vis. viij*d.*, et in denariis quos posuit pro dictis florenciis reassumptis pro annulis medicinalibus inde faciendis, eodem die, vis. : summa xii*s.* viii*d.*' [For the offering of the lord King to the Gneythe Cross on Good Friday in his chapel, in his manor of Clipstone, to the value of two florins, on the 14th day of April, vis. viii*d.*, and for the pence bestowed in redemption of the said florins for the making of medicinal rings, on the same day, vis. : total xii*s.* viii*d.*]

Again, in the Eleemosyna Roll of the following year, 10 Edward III : ²

'In oblacione domini Regis ad crucem de Gneyth in die parasceues apud Eltham, $\overline{\text{xxix}}$ die Marcii, vs., et pro iisdem denariis reassumptis pro annulis inde faciendis per manus Iohannis de Crokeford eodem die, xs.'

In this entry the name of the almoner is introduced, and the form of the account is abbreviated by omitting repetition of the substituted *vs.*

¹ *Gent's Mag.*, N.S., vol. i ; British Museum MS. Cotton Nero C. viii, f. 209.

² MS. Cotton Nero C. viii, ff. 212, 213b, and *Gent's Mag.*, N.S., vol. i.

And in 11 Edward III : ¹

‘ In oblacione domini regis ad crucem de Gneyth in capella sua in p̄cho de Wyndesore die parasceues, vs., et pro totidem denariis reassumptis pro annulis inde faciendis vs.’

Here the sum total is omitted: the three entries, though mutually explanatory, show how puzzling becomes a too strict economy of words.

Entries substantially the same as these may be seen in the Wardrobe Accounts of 12–14 Edward III.²

One more entry from the Account Books of John de Ypres, 44 Edward III, is perhaps worth quoting, as it seems to point definitely to the rings being made in this instance of both gold and silver :

‘ In oblacionibus Regis factis adorando crucem in capella sua infra castrum suum de Wyndesore die parasceues in pretio trium nobilium auri et quinque solidorum sterling xxvs.—In denariis solutis pro iisdem oblacionibus reassumptis pro annulis medicinalibus inde faciendis, eodem die xxv.’

The offering of both gold and silver money would seem to bear out the suggestion as to the material of the rings, as we know that in later times both metals were used. It is, of course, arguable that the larger sum of money indicates only a greater demand for the rings.

Richard II’s Account Books³ show that he maintained the practice of his grandfather. The following is from an account of the Controller of the Wardrobe in his reign :

‘ in denar̄ solut̄ decano capelle Regis pro eisdem oblacionibus reassumpt̄ pro anulis medicinal̄ inde faciendis, xxvs.’

The substituted money seems to have been actually laid on the altar, and removed thence to be made into rings: this will explain payment being made in this case to the Dean of the Chapel Royal.

Henry IV could ill afford to dispense with any of the prerogatives of royalty, and we find him offering 25 shillings in the chapel of the palace of Eltham for the making of medicinal rings.⁴

It is no matter for surprise that no mention should be forthcoming of cramp-rings in the reign of Henry V, most of which was

¹ loc. cit.

² Record Office, Exchqr. Tr. of R., Mis. Book 203, pp. 150–3.

³ Record Office, Exchqr. Q. R., Accounts 403/10.

⁴ British Museum Harleian MS. 319: Household Accounts of Henry IV, 1405–6.

spent beyond the shores of England, and in the propagation rather than in the relief of disease. A passage, however, in the literary remains of Sir John Fortescue ¹ taken from a tract entitled *Defensio Iuris Domus Lancastriae*, now to be seen in the Cotton Collection at the British Museum, and referable to the year A. D. 1462, seems to show that the practice had not been allowed to lapse during his memory, which ranged over the reigns of Henry IV, V, and VI. The translated passage runs thus :

‘ Many duties likewise are incumbent on the Kings of England in virtue of the kingly office, which are inconsistent with a woman’s nature, and Kings of England are endowed with certain powers by special grace from heaven, wherewith Queens in the same country are not endowed. The Kings of England at their very anointing receive such an infusion of grace from heaven, that by touch of their anointed hands they cleanse and cure those infected with a certain disease, that is commonly called the King’s Evil, though they be pronounced otherwise incurable. Epileptics too, and persons subject to the falling sickness, are cured by means of gold and silver devoutly touched and offered by the sacred anointed hands of the kings of England upon Good Friday, during divine service (according to the ancient custom of the Kings of England) ; as has been proved by frequent trial of rings, made of the said gold and silver and placed on the fingers of sick persons in many parts of the world. The gift is not bestowed on Queens, as they are not anointed on the hands.’

The passage also brings out the fact that the use of both gold and silver rings had long been customary.

We have abundant evidence of the maintenance of the ceremony under Edward IV in a number of separate entries. Thus in an Eleemosyna Roll of 8 Edward IV is the following : ‘ Pro eleemosyna in die paraseveves c. marc. et pro annulis de auro et argento pro eleemosyna Regis eodem die.’ And in a Liber Niger Domus Regis Edwardi IV : ‘ Item, to the Kynge’s offerings to the crosse on Good Friday, out from the counting-house for medycynable rings of gold and silver, delyvered to the jewell house xxvs.’ And again in a Privy Seal Account of 9 Edward IV : ‘ Item, paid for the King’s Good Fryday rings of gold and silver xxxiiii. vis. viiiid.’ Edward IV seems to have aimed at fortifying himself upon the throne by a liberal use of the Royal Gift of Healing, and I have elsewhere expressed my belief, in the absence of any written evidence, that

¹ See R. Crawford, *King’s Evil*, p. 45, Oxford, 1911.

it was in his reign, and not in that of Henry VII, as commonly believed, that the dole of the angel to those touched by the King for the Evil was instituted. Cramp-rings are mentioned in the Comptroller's Accounts of 20 Henry VII, but the Tudors certainly devoted their healing powers chiefly to sufferers from the Evil.

There is a passage in the *Historia Anglicana* of Polydore Vergil,¹ the Italian, who came to live in England in A. D. 1502, and wrote his history during the reigns of Henry VII and VIII, which shows the nature of the patients for whom these sacred rings were used.

‘Iste annulus in eodem templo (scil. Westmonasterii), multâ veneratione perdiu est servatus, quod salutaris esset membris stupentibus valeretque adversus comitiale morbum, cum tangeretur ab illis, qui eiusmodi tentarentur morbis. Hinc natum, ut reges postea Angliæ consueverint in die Parasceues, multâ coeremoniâ sacrare annulos, quos qui induunt, hisce in morbis omnino nunquam sunt.’

Besides true epileptics, they were used for those who had palsied limbs: this is interesting as suggesting the inclusion of Jacksonian epilepsy, and perhaps hemiplegia, and the resulting contractures in these conditions may have contributed to the confusion with contractures from other causes, such as chronic rheumatism. We have to bridge over in some such way the gap between their conception of ‘cramp’ and ours.

In the will of John Baret of Bury St. Edmunds,² dated 1463, is a bequest to ‘my lady Walgrave’ of a ‘rowund ryng of the Kynges silver’; and also to ‘Thomais Brews, esquier, my crampe ryng with blak innamel, and a part silvir and gilt.’ And in 1535 Edmund Lee bequeaths to ‘my nece Thwartow my gold ryng w^t a turkes, and a crampe ryng of gold w^t all.’

There are even earlier bequests than this of healing-rings,³ but not specifically termed cramp-rings: they are simply spoken of as ‘vertuosi’. Thus Thomas de Hoton, rector of Kyrkebymisper-ton, in 1351, bequeathed to his chaplain ‘j. zonam de serico, j. bonam bursam, j. firmaculum, et j. anulum vertuosum. Item, domino Thome de Bouthum j. par de bedes de corall, j. anulum vertuosum.’ Talismanic rings, inscribed with the names of the three Magi, Caspar, Melchior, Balthazar, were used as preservatives from epilepsy in Plantagenet times.

¹ Lib. i, chap. 8.

² *Bury Wills*, p. 35, Camden Soc., ed. Tymms.

³ *Archæol. Journal*, London, vol. iv, p. 78.

The royal cramp-rings enjoyed no monopoly in the cure of epilepsy, as is shown by an extract from a medical treatise written in the fourteenth century :¹

‘ For the Crampe. Tak and ger gedine on Gude Friday, at fyfe parriche kirkes, fife of the first penyes that is offerd at the crosse, of ilk a kirk the first peny : than tak them al and ga before the crosse and say V. pater nosters in the worschip of fife wondes, and bere thaim on the V. dais, and say ilk a day als mekyl on the same wyse : and then gar mak a ryng thar of with owten alay of other metel, and writ with in Jasper, Batasar, Altrapa, and writ with outhen Ih’ c. nazareus ; and sithen tak it fra the goldsmyth upon a Fridai, and say V. pater nosters als thu did before and use it alway afterward.’

The ‘fife wondes’ are, of course, the five wounds of the crucified Jesus.

A silver ring, made of five sixpences contributed by five different bachelors, conveyed by a bachelor to the hand of a smith that was also a bachelor, was another reputed remedy for epilepsy ; and its virtue was enhanced, if none of the bachelors knew for what purpose or to whom it was given.²

In Berkshire, rings made from a piece of silver collected at the Communion found favour, and they were more efficacious if collected on Easter Sunday. Devonshire preferred a ring made of three nails or screws that had been used to fasten a coffin, and that had been dug out of a churchyard.³

Cramp-rings hallowed by the King of England enjoyed repute beyond the shores of England.⁴ Lord Berners, the translator of Froissart, when ambassador to Charles V, writing to ‘my Lorde Cardinall’s grace from Saragoza, the xxi daie of June, 1510’, says : ‘If your grace remember me with some crampe rynges ye shall do a thyng mucche looked for, and I trust to bestow thaim well, with Godd’s grace, who evermor preserve and encrease your moste reverent astate.’ Among various charms that Charles V carried about with him were ‘gold rings from England against cramp’.⁵

In A. D. 1518 we find the President of the College of Physicians lending his patronage to the royal cramp-rings. In a letter to the Parisian scholar, Guillaume Budé,⁶ Thomas Linacre writes

¹ British Museum MS. Arundel, fol. 23b, and *Gent’s Mag.*, N.S., vol. i, p. 49.

² *Gent’s Mag.*, 1794.

³ Brand, *Pop. Antiq.*, ii. 598.

⁴ *Gent’s Mag.*, N.S., vol. i, p. 49.

⁵ *Cloister Life of Charles V*, p. 109.

⁶ Brewer, *State Papers ; Budaei Epistolae*, June 10, 1518, 4223.

that he 'has sent him some rings consecrated by the King as a charm against Spasms': and on July 10, 1518, Budé replies to him from Paris that he has 'received his letter with the rings on July 6', and has distributed among the wives of his relatives and friends the eighteen rings of silver and one of gold he received from Linacre, telling them that they were amulets against slander and calumny.

Even the hard-headed Scot was not proof against the magnetism of the royal rings. A letter from Dr. Thomas Magnus, Warden of Sibthorpe College, Nottinghamshire, to Cardinal Wolsey,¹ written in A. D. 1526 says :

'Pleas it your Grace to write that M. Wiat of his goodnes sent unto me for a present certaine cramp ringges, which I distributed and gave to sondery myne acquaintaunce at Edinburghe, amonges other to M. Adame Otterbourne, who, with oone of thayme, releved a mann lying in the falling sekenes, in the sight of myche people: sethenne which tyme many requestes have been made unto me for cramp ringges, at my departing there, and also sethenne my comyng from thennes. May it pleas your Grace therefore to show your gracious pleasure to the said M. Wyat, that some ringges may be kept and sent into Scottelande; whiche after my poore oppynioun shulde be a good dede, remembering the power and operacion of thaym is knowne and proved in Edinburgh, and that they be gretly required for the same cause both by grete personnages and other.'

When Bishop Gardiner was in Rome in A. D. 1529, Anne Boleyn wrote him the following letter: ²

Master Stephyns,

I thank you for my letter, wherein I perceive the willing and faithful mind that you have to do me pleasure, not doubting, but as much as is possible for man's wit to imagine, you will do. I pray God to send you well to speed in all your matters, so that you would put me to the study, how to reward your high service: I do trust in God you shall not repent it, and that the end of this journey shall be more pleasant to me than your first, for that was but a rejoicing hope, which causing the like of it, does put me to the more pain, and they that are partakers with me, as you do know: and therefore I do trust that this hard beginning shall make the better ending.

Master Stephyns, I send you here cramp-rings for you and Master Gregory, and Mr. Peter, praying you to distribute them as you think best. And have me kindly recommended to them both,

¹ *Gent's Mag.*, loc. cit., and British Museum MS. Cotton Calig. B. ii, fol. 112.

² Burnet, *Hist. of Reformation*, part ii, book ii, record 24.

as she that you may assure them, will be glad to do them any pleasure, which shall be in my power. And thus I make an end, praying God send you good health.

Written at Grenwiche, the 4th day of April,
By your assured friend,

ANNE BOLEYN.

[To Master Stephyns this be delivered.]

Burnet¹ refers to this letter, as follows :

‘When he [Gardiner] went to Rome, in the year 1529, Anne Boleyn writ a very kind letter to him, which I have put in the Collection (Records No. 24). By it, the reader will clearly perceive that he was then in the secret of the King’s designing to marry her as soon as the divorce was obtained. There is another particular in that letter, which corrects a conjecture which I had set down in the beginning of the former book concerning the cramp rings that were blessed by King Henry, which I thought might have been done by him after he was declared head of the Church.² That part was printed before I saw this letter : but this letter shows they were used to be blessed before the separation from Rome : for Anne Boleyn sent them as great presents thither. This use of them had been (it seems) discontinued in King Edward’s time : but now, under Queen Mary, it was designed to be revived, and the office for it was written out in a fair MS. yet extant, of which I have put a copy in the Collection (No. 25). But the silence in the writers of that time makes me think it was seldom if ever practised.’

Queen Mary’s Manual, of which we shall have more to say later, seems to have been the source from which Burnet transcribed the Office. In his time it was in the library of R. Smith, titular Bishop of Chalcedon.

Numerous allusions in the records of the De Lisle family bear testimony to the popularity of cramp-rings in the reign of Henry VIII.³ Edward Seymour, Earl of Hertford and afterwards Duke of Somerset, writes to Lady Lisle, in 1537 :

‘Hussey told me you were very desirous to have some cramp-rings against the time that you should be brought a bedd. . . . I send by the present messenger 18 cramp-rings, which you should have had long ago.’⁴

John Husee writes from London on April 17, 1535, to his mistress, Lady Lisle : ‘I send you by Mr. Degory Gramefilld 59 cramp rings

¹ *Hist. of Reformation*, part ii, book ii.

² A.D. 1534.

³ *Lisle Papers and Notes and Queries*, 5th series, vol. ix, p. 514.

⁴ *Lisle Papers*, xi. 15.

of silver, that Christofer Morys giveth you, and one of gold';¹ and again, on May 2, 1538: 'Cramp-rings I can get none out of the jewel-house. Mr. Wyll^ms says the King had the most part of gold, but has promised me twelve silver.'²

In a letter of May 13, 1536, John Husee combines denunciation of Anne Boleyn with a promise of cramp-rings to Lady Lisle:

'Madam, I think verily that if all the books and cronycelés were totally revolved and to the uttermost proscuted and tried, which against wymen hath been pennyd, contryvyd, and wryten, syns Adam and Eve, these same were I think verily nothing in comparison with that which hath been done and committed by Anne the Queen. . . . I think not the contrary but she and all they shall suffre. John Williams hath promised me some cramp rings for your Ladyship';³

and again, six days after:

'Your ladyship shall receive of this berer 9 cramp-rings of silver. John Williams says he never had so few of gold as this year. The king had the most part himself: but next year he will make you amends.'⁴

This day, May 19, 1536, was the day of Anne Boleyn's execution.

Margaret Mylynton, in 1516, bequeaths to 'my dame Croche my best gown and a kercheve, and my cramp-ring'.⁵ There is nothing, however, to show that it had received the royal benediction.

Andrew Boorde, in his *Introduction of Knowledge*, says, 'the kynges of Englande doth halowe every yere crampe rynges, ye which rynges worne on ones fynger doth help them whych hath the crampe'; and again, in his *Breviarie of Health*, published in 1547, but written during the lifetime of Henry VIII: 'The kynges majesty hath a great helpe in this matter, in hallowing crampe rynges, and so given without money or petition.' Boorde was medical attendant to Thomas, eighth Duke of Norfolk, Lord President of the Council and uncle of Anne Boleyn, and by him was recommended to the notice of Henry VIII, who employed him much in State business, but not, so far as is known, in a medical capacity. His testimony therefore is peculiarly reliable, and shows

¹ *Lisle Papers*, xi. 111.

² *Ibid.*, xii. 43.

³ *Ibid.*, xii. 58.

⁴ *Ibid.*, xii. 60.

⁵ Registry of Wills, Archdeaconry of Norwich.

that Henry VIII maintained the ceremony throughout his reign, as is borne out by the scattered references we have adduced from other contemporary sources.

In 1547, after the death of Henry VIII, Gardiner sent a letter to Ridley, which contains the following passage :

‘The late king used to bless cramp rings both of gold and silver, which were much esteemed everywhere, and when he was abroad they were often desired from him. The gift he hoped the young king would not neglect. He believed the invocation of the name of God might give such a virtue to holy water as well as to the water of baptism,’ and further he speaks of the rings as endued ‘by the special gift of curation ministered to the king of this realm’.¹

That Edward VI did not relinquish the practice of blessing cramp-rings, as has been supposed, and as Burnet submits, is conclusively proved by an entry in the Household Accounts of the year 1553, before his death. Under the heading ‘Oblations’ is 25 shillings for the redemption of rings commonly called medicine rings, to be made of gold and silver.²

It was little likely that Mary would allow a Catholic ceremonial to lapse for want of royal patronage. In the Appendix to *Illustrations of the manners and expences of antient times in England, in the 15th, 16th, and 17th centuries, deduced from the accompts of churchwardens and other authentic documents, London, 1797, 4to*, printed in the same year, is a list of the New Year’s gifts presented by Queen Mary in 1556, among which we find :

‘Item, deliuerid by the queins commandement—to the said Robert Raynes, in broken golde, to make crampe rings, etc. Item, more deliuerid the same time, to make cramp ringes, in broke plate of silu’ theise parcelles,’ &c.

But there is further the evidence of the actual existence of Queen Mary’s Illuminated MS. Manual, in the Library of the Roman Catholic Cathedral of Westminster, giving the Office of the Blessing of Cramp-rings in Latin, with rubrics in English showing it to be the form made use of by herself. It also contains a miniature painting of Queen Mary performing the service of consecration. The whole office is transcribed below. A full description of the Manual will be found in the *Proceedings of the Society of Anti-*

¹ Burnet, *Hist. of Reformation*, part ii, book i, § 12.

² British Museum Additional MS. 35184, Household Account, 1553.

quaries,¹ at a meeting of whom it was shown and described by Sir Henry Ellis. Sparrow Simpson has also described it in the *Journal of the Archaeological Association*, 1871. It is a 'small quarto volume, eight and a half inches in height by six and three-eighths in width'. Cardinal Wiseman, to whom it formerly belonged, has written on the fly-leaf, 'Queen Mary's manual for blessing cramp-rings and touching for the Evil. Bound 1850.' The cover is spangled with roses and fleurs-de-lis, together with the Queen's monogram MR. 'The volume consists of nineteen leaves of vellum, each surrounded with a rich border, and filled either with miniatures or with the two offices which it comprises. Then follow four ruled leaves and fifteen plain leaves without manuscript. . . . On the recto of leaf 1 the royal arms of Philip and Mary are emblazoned, surrounded by a garter and surmounted by a crown. A rich border containing the rose, the fleur-de-lis, and the pomegranate, together with a shield bearing the cross of St. George, completes the decorations of the page.' The red and white roses represent Queen Mary's double title to the throne of England as the heiress of the houses of Lancaster and York, the fleur-de-lis her claim to the throne of France, and the pomegranate of Granada her descent from Ferdinand and Isabella. The Cross of St. George is derived from the shield of the Order of the Garter. 'On the verso of this leaf is an illumination (Plate XL) representing the interior of a chapel with an altar furnished with curtains, candlesticks, and crucifix. At a prayer-desk before the altar kneels the Queen; before her is an open book, and on either side two golden basins containing cramp-rings.' Leaves 2 to 10 contain 'certain prayo's to be used by the quenes heighnes in the consecration of the crampe ryngs'. A study of the rubrics, which are in English, suffices 'to show the essentials for the consecration of the rings: the prayers, the royal touch, the holy water. . . . The recto of leaf 11 is filled with an illumination of the Crucifixion with St. Mary and St. John. In the border are the instruments of the Passion—the spear, the reed and sponge, the hammer and pincers, three nails, two scourges, and (a very unusual addition) a centre-bit of the same form as that now in use. On the verso of this leaf is a very interesting full-page illumination. At a prayer-desk, on which is an open book, kneels the Queen, turning to the right (the dexter side of the picture), wearing the head-dress familiar to us in all her portraits.

¹ Series i, vol. ii, p. 292.



PLATE XL. QUEEN MARY TUDOR
BLESSING CRAMP-RINGS
From QUEEN MARY'S MS. MANUAL fo. IV
Library of the Roman Catholic Cathedral
at WESTMINSTER

Before her kneels a sufferer, apparently a young man, whose bare and swollen neck the Queen holds between her two hands. Behind him, holding open the collar of the patient's coat, kneels the "clarke of the closett" in a cassock and gown, and with a tonsured head. On the left of the prayer-desk stands "the chaplen", a bald-headed, venerable man in a long cassock, a somewhat short surplice with full sleeves, and the "stole abowte his neck" ordered in the rubric, reading the appointed office. The Queen wears a brown dress cut square at the neck, white sleeves, and a lace ruff and waistbands. The office for the healing follows, commencing on folio 12*a*, and ending on folio 19*a*.

'The rubrics are in red ink, bright and fresh; and each page has a rich border of scrolls, leaves, flowers, and fruit, with occasional figures of children, &c. I enumerate the most important subjects. Folio 1*b*, David with head of Goliath, St. George and the Dragon, and a child with a skull; folio 2*b*, arms of the city of London; folio 3*a*, VERITAS TEMPORIS FILIA (the Queen's favourite motto), with a sword and sceptre; folios 3*b* and 4*a*, large terminal figures with grapes; folio 4*a*, arms of France and England quarterly; folio 4*b*, DÑS MIHI ADIVTOR; folios 5*a* and *b*, porteullis and rose; folios 6*a* and *b*, PACIENTIA and PRVDĒTIA, with allegorical figures; folios 7*a* and *b*, CHARITAS and IVSTICIA; folios 8*a* and *b*, FIDES and SPES; folios 9*a* and *b*, FORTITVDO and TEMPERANCIA.'

With the death of Mary, the ceremonial seems finally to have fallen into disuse. There is, however, a passage in the *Historia Anglicana Ecclesiastica* of Nicholas Harpsfield,¹ which was written entirely in the reign of Elizabeth, which seems to throw some doubt on the point. The words are as follows:

'Quin et annulus ille, de quo diximus, magna in Westmonasteriensi Londini coenobio postea reverentia reservatus, adversus comitalem morbum multis profuit: indeque etiam ortum, ut ad sacram parasceuen Reges Angliae certos annulos statis quibusdam precibus et caerimoniis consecrare consueverint, adversus eundem morbum salutare. Quae consuetudo et ad nostra usque tempora perducta est, multique huiusmodi annulorum beneficium, nostra etiam aetate, senserunt.' [And further the above-mentioned ring was reverently preserved afterwards in the monastery of Westminster in London, and relieved many of epilepsy. That too was the origin of the custom of the Kings of England on Good Friday consecrating certain rings with set prayers and ceremonies, for the

¹ Ed. 1622, p. 219.

cure of the same disease. Which custom has persisted even down to our own times, and many even in our own lifetimes have derived benefit from rings of this kind.]

Nicholas Harpsfield, though he did not write till the reign of Elizabeth, was born as early as A.D. 1519, so that his words are consistent with discontinuance of the ceremony after the time of Queen Mary.

It remains to consider what diseased states were embraced by the term 'cramp'. Epilepsy, convulsions, and rheumatism certainly. All these terms have in common the idea of muscular contraction or spasm, and their relation in usage to one another may be represented graphically as under :

$$\begin{array}{l} \text{Convulsion} \searrow \\ \text{Epilepsy} \quad \swarrow \end{array} \text{Cramp} = \text{Rheumatism.}$$

Confusion of these terms is far more marked in medical than in lay writers ; but at the same time there is little doubt that the conservative sentiment inspired by the royal ceremonial kept the term 'cramp' alive in a sense that was all but obsolete in the common diction.

Chaucer applies 'crampe' to muscular spasm :

But wel he felte about his herte crepe . . .

The crampe of death, to streyne him by the herte.¹

Linacre, as we have seen, speaks of cramp-rings, in 1518, as a charm against *spasms*, while about the same year Polydore Vergil speaks of the royal cramp-rings as a cure for the *morbis comitialis*. Each of these two writers clearly indicates epilepsy. In 1526 Magnus speaks definitely of cramp-rings as relieving a man lying in the *falling-sickness*, a term habitually applied to epilepsy. Nicholas Harpsfield too, writing in the middle of the reign of Elizabeth, speaks of cramp-rings blessed by the kings as remedies for the *morbis comitialis*. In all probability royal cramp-rings were used for epilepsy and epilepsy only, but it is quite possible, and I am inclined to think probable, that other cramp-rings had a less exclusive use.

Bacon's description of cramp in his *Natural and Experimental History* is fairly explicit and obviously does not embrace epilepsy : 'The cramp cometh of contraction of sinews, which is manifest, in that it comes either by cold or dryness.'

¹ *Troilus*, book iii, ¶1069.

Shakespeare recognizes both epilepsy and rheumatism as entities apart from cramp. Epilepsy he seems to associate more with falling than with convulsion: thus, of the fit that attacked Caesar when the crown was offered to him, he writes:

Casca. He fell down in the market-place, and foamed at mouth, and was speechless.

Brutus. 'Tis very like: he hath the falling-sickness.¹

'Cramp' is used by Shakespeare for muscular spasms or contractures, and he links the term on the one side to rheumatism, and on the other to convulsions, in the following passages:

For this, be sure, to-night thou shalt have cramps,
Side-stitches that shall pen thy breath up.²

Parolles says:

'In a retreat he outruns any lackey: marry, in coming on he has the cramp.'³

Prospero says:

Go, charge my goblins that they grind their joints
With dry convulsions; shorten up their sinews
With aged cramps.⁴

and

'Leander . . . went but forth to wash him in the Hellespont, and being taken with the cramp was drowned.'⁵

Robert Bayford, in his *Enchiridion Medicum* published in 1655, includes both wry-neck and convulsions under the heading cramp, but he treats epilepsy separately on the ground that, as we know to be the case, it is not always associated with convulsions. He has no word 'rheumatism' at all.

Pepys (1664) carried about with him a hare's foot as a charm against *colic*, i. e. against muscular spasm. Among Indians, Norwegians, and Central Africans, the foot of an elk was a charm against epilepsy. Pepys also recites a charm against cramp:

Cramp, be thou faintless
As our Lady was sinless
When she bare Jesus.

In this charm the word cramp seems to refer to the painful *muscular spasms* of labour. Pepys, as we know, suffered from colic, but not

¹ *Julius Caesar*, I. ii.

² *Tempest*, I. ii.

³ *All's Well that Ends Well*, IV. iii.

⁴ *Tempest*, IV. i.

⁵ *As You Like It*, IV. i.

from epilepsy, so in using a hare's foot as a charm against colic he was probably employing a charm against epilepsy. In like manner the 'rheumatic ring' of to-day seems to be the lineal descendant of the cramp-ring of aforetime, and the confusion of nomenclature has doubtless not affected its efficacy. Folk-medicine serves rather to confirm than to elucidate the confusion, for in Suffolk moles' feet are carried as a charm against rheumatism, but in Sussex against cramp. In Devonshire a dried frog is worn as a cure for fits.

Boswell, in his description of Johnson at the time of their tour to the Hebrides, uses the word 'cramp' in its earlier significance. 'His head,' he says, 'and sometimes also his body, shook with a kind of motion like the effect of a palsy: he appeared to be frequently disturbed by cramps, or convulsive contractions, of the nature of that distemper called St. Vitus's dance.'

It may be asked how it came about that rings were used in the first instance as a remedy for epilepsy. It has occurred to me that their use may have originated in the time-honoured belief that an epileptic seizure may be aborted by ligature of a limb or part above the situation in which the warning 'aura' commences. Galen, Alexander of Tralles, Rhazes, and Avicenna, among the earlier writers on medicine, all recommend the measure.

THE OFFICE OF CONSECRATING THE CRAMP-RINGS

Certain prayers to be used by the queen's highness, in the consecration of the cramp-rings.

Deus misereatur nostri et benedicat nos Deus, illuminet vultum suum super nos et misereatur nostri.

Ut cognoscamus in terra viam tuam, in omnibus gentibus salutare tuum.

Confiteantur tibi populi Deus, confiteantur tibi populi omnes.

Laetentur et exultent gentes, quoniam iudicas populos in aequitate, et gentes in terra dirigis.

Confiteantur tibi populi Deus, confiteantur tibi populi omnes, terra dedit fructum suum.

Benedicat nos Deus, Deus noster, benedicat nos Deus, et metuent eum omnes fines terrae.

Gloria Patri, et Filio, et Spiritui Sancto.

Sicut erat in principio, et nunc, et semper, et in saecula saeculorum, Amen.

Omnipotens sempiterne Deus, qui ad solatium humani generis, varia ac multiplicia miseriarum nostrarum levamenta uberrimis gratiae tuae donis

ab inexhausto benignitatis tuæ fonte manantibus incessanter tribuere dignatus es, et quos ad regalis sublimitatis fastigium extulisti, insignioribus gratiis ornatos, donorumque tuorum organa atque canales esse voluisti, ut sicut per te regnant aliisque præsent, ita te authore reliquis prosint, et tua in populum beneficia conferant: preces nostras propitius respice, et quæ tibi vota humillime fundimus, benignus admitte, ut quod a te maiores nostri de tua misericordia sperantes obtinuerunt, id nobis etiam pari fiducia postulantibus concedere digneris. Per Christum Dominum nostrum. Amen.

The rings lying in one bason, or more, this prayer to be said over them.

Deus coelestium terrestriumque conditor creaturarum, atque humani generis benignissime reparator, dator spiritualis gratiæ, omniumque benedictionum largitor, immitte Spiritum Sanctum tuum Paracletum de coelis super hos annulos arte fabrili confectos, eosque magna tua potentia ita emundare digneris, ut omni nequitia lividi venenosique serpentis procul expulsa, metallum a te bono conditore creatum, a cunctis inimici sordibus maneat immune. Per Christum Dominum nostrum. Amen.

Benedictio annulorum.

Deus Abraham, Deus Isaac, Deus Iacob, exaudi misericors preces nostras, parce metuentibus, propitiare supplicibus, et mittere digneris sanctum Angelum tuum de coelis qui sanctificet ✠ et benedicat ✠ annulos istos, ut sint remedium salutare omnibus nomen tuum humiliter implorantibus, ac semetipsos pro conscientia delictorum suorum accusantibus, atque ante conspectum divinæ clementiæ tuæ facinora sua deplorantibus, et serenissimam pietatem tuam humiliter obnixæque flagitantibus; prosint denique per invocationem sancti tui nominis omnibus istos gestantibus, ad corporis et animæ sanitatem. Per Christum Dominum nostrum. Amen.

Benedictio.

Deus qui in morbis curandis maxima semper potentiæ tuæ miracula declarasti, quique annulos in Iuda patriarcha fidei arrabonem, in Aarone sacerdotale ornamentum, in Dario fidelis custodiæ symbolum, et in hoc regno variorum morborum remedia esse voluisti, hos annulos propitius ✠ benedicere et ✠ sanctificare digneris: ut omnes qui eos gestant sint immunes ab omnibus Satanae insidiis, sint armati virtute coelestis defensionis, nec eos infestet vel nervorum contractio, vel comitalis morbi pericula, sed sentiant te opitulante in omni morborum genere levamen. In nomine Patris ✠ et Filii ✠ et Spiritus Sancti ✠. Amen.

Benedic anima mea Domino: et omnia quæ intra me sunt nomini sancto eius. *Here follows the rest of that Psalm.*

Immensam clementiam tuam misericors Deus humiliter imploramus, ut qua animi fiducia et fidei sinceritate, ac certa mentis pietate, ad hæc impetranda accedimus, pari etiam devotione gratiæ tuæ symbola fideles prosequantur: facessat omnis superstitio, procul absit diabolicæ fraudis suspicio, et in gloria tui nominis omnia cedant: ut te largitorem bonorum omnium fideles tui intelligant, atque a te uno quicquid vel animis vel corporibus vere prosit, profectum sentiant et profiteantur. Per Christum Dominum nostrum. Amen.

These prayers being said, the queen's highness rubbeth the rings between her hands, saying :

Sanctifica Domine annulos istos, et rore tuae benedictionis benignus asperge, ac manuumstrarum confricatione, quas, olei sacra infusione externa, sanctificare dignatus es pro ministerii nostri modo, consecra, ut quod natura metalli praestare non possit, gratiae tuae magnitudine efficiatur. Per Christum Dominum nostrum. Amen.

Then must holy water be cast on the rings, saying :

In nomine Patris, et Filii, et Spiritus Sancti. Amen. Domine Fili Dei unigenite, Dei et hominum Mediator, Iesu Christe, in cuius unius nomine salus recte quaeritur, quique in te sperantibus facilem ad Patrem accessum conciliasti, quem quicquid in nomine tuo peteretur, id omne daturum, cum certissimo veritatis oraculo ab ore tuo sancto, quum inter homines versabaris homo pronuntiasti, precibus nostris aures tuae pietatis accommoda, ut ad thronum gratiae in tua fiducia accedentes, quod in nomine tuo humiliter postulavimus, id a nobis, te mediante, impetratum fuisse, collatis per te beneficiis, fideles intelligant. Qui vivis et regnas cum Deo patre in unitate Spiritus Sancti Deus, per omnia saecula saeculorum. Amen.

Vota nostra quaesumus Domine, Spiritus Sanctus qui a te procedit, aspirando praeveniatur, et prosequatur, ut quod ad salutem fidelium confidenter petimus, gratiae tuae dono efficaciter consequamur. Per Christum Dominum nostrum. Amen.

Maiestatem tuam clementissime Deus, Pater, Filius, et Spiritus Sanctus, suppliciter exoramus, ut quod ad nominis tui sanctificationem piis hic ceremoniis peragitur, ad corporis simul et animae tutelam valeat in terris, et ad uberiorem felicitatis fructum proficiat in coelis.

Qui vivis et regnas Deus, per omnia saecula saeculorum. Amen.

THE CEREMONIES OF BLESSING CRAMP-RINGS, ON GOOD FRIDAY, USED BY THE CATHOLICK KINGS OF ENGLAND

The psalme ' Deus misereatur nostri, etc.', with the ' Gloria Patri '.

May God take pity upon us and blesse us : may he send forth the light of his face upon us, and take pity on us.

That we may know thy ways on earth : among all nations thy salvation.

May people acknowledge thee, O God : may all people acknowledge thee.

Let nations rejoice and be glad, because thou judgest people with equity : and doest guide nations on the earth.

May people acknowledge thee, O God, may all people acknowledge thee : the earth has sent forth her fruit.

May God blesse us, that God who is ours : may that God blesse us : and may all the bounds of the earth feare him.

Glory be to the Father, and to the Son : and to the holy Ghost.

As it was in the beginning, and now, and ever : and for ever and ever. Amen.

Then the king reads this prayer :

Almighty eternal God, who by the most copious gifts of thy grace flowing from the unexhausted fountain of thy bounty, hast been graciously

pleased for the comfort of mankind, continually to grant us many and various means to relieve us in our miseries, and art willing to make those the instruments and channels of thy gifts, and to grace those persons with more excellent favours, whom thou hast raised to the royal dignity ; to the end that as by thee they reign and govern others, so by thee they may prove beneficial to them, and bestow thy favours on the people : graciously heare our prayers and favourably receive those vows we powre forth with humility, that thou mayest grant to us, who beg with the same confidence, the favour which our ancestors by their hopes in thy mercy have obtained, through Christ our Lord. Amen.

The rings lying in one bason, or more, this prayer is to be said over them :

O God, the maker of heavenly and earthly creatures, and the most gracious restorer of mankind, the dispenser of spiritual grace, and the origin of all blessings : send downe from heaven thy holy Spirit the Comforter upon these rings, artificially fram'd by the workman, and by thy greate power purify them so, that all the malice of the fowle and venomous serpent be driven out ; and so the metal, which by thee was created, may remaine pure and free from all the dregs of the enemy, through Christ our Lord. Amen.

The blessing of the rings.

O God of Abraham, God of Isaac, God of Jacob, heare mercifully our prayers. Spare those who feare thee. Be propitious to thy suppliants, and graciously be pleased to send downe from heaven thy holy angel : that he may sanctify ✠ and blesse ✠ these rings : to the end they may prove a healthy remedy to such as implore thy name with humility, and accuse themselves of the sins which ly upon their conscience : who deplore their crimes in the sight of thy divine clemency, and beseech with earnestnes and humility thy most serene pity. May they in fine by the invocation of thy holy name become profitable to all such as weare them, for the health of their soule and body, through Christ our Lord. Amen.

A blessing.

O God, who has manifested the greatest wonders of thy power by the cure of diseases, and who were pleased that rings should be a pledge of fidelity in the patriark Judah, a priestly ornament in Aaron, the mark of a faithful guardian in Darius, and in this kingdom a remedy for divers diseases : graciously be pleased to blesse ✠ and sanctify ✠ these rings, to the end that all such as weare them may be free from all snares of the devil, may be defended by the power of celestial armour, and that no contraction of the nerves or any danger of the falling-sickness may infest them, but that in all sort of diseases by thy help they may find relief. In the name of the Father, ✠ and of the Son, ✠ and of the Holy Ghost ✠ . Amen.

Blesse, O my soule, the Lord : and let all things which are within me praise his holy name.

Blesse, O my soule, the Lord : and do not forget all his favours.

He forgives all thy iniquities : he heales all thy infirmities.

He redeemes thy life from ruin : he crownes thee with mercy and comiseration.

He fils thy desires with what is good : thy youth like that of the eagle shal be renewed.

The Lord is he who does mercy : and does justice to those who suffer wrong.

The merciful and pitying Lord : the long sufferer and most mighty merciful.

He will not continue his anger for ever : neither wil he threaten for ever.

He has not dealt with us in proportion to our sins : nor has he rendred unto us according to our offences.

Because according to the distance of heaven from earth : so' has he enforced his mercies upon those who feare him.

As far distant as the east is from the west : so far has he divided our offences from us.

After the manner that a father takes pity of his sons ; so has the Lord taken pity of those who feare him : because he knows what we are made of.

He remembers that we are but dust : man like hey such are his days : like the flower in the field so wil he fade away.

Because his breath wil passe away through him, and he wil not be able to subsist : and it wil find no longer its owne place.

But the mercy of the Lord is from all eternity : and will be for ever upon those who feare him.

And his justice comes upon the children of their children : to those who keep his wil.

And are mindful of his commandements : to performe them.

The Lord in heaven has prepared himselfe a throne : and his kingdom shall reign over all.

Blesse yee the Lord all yee angels of his, yee who are powerful in strength : who execute his commands, at the hearing of his voice when he speakes.

Blesse yee the Lord all yee vertues of his : yee ministers who execute his wil.

Blesse yee the Lord all yee works of his throughout all places of his dominion : my soule praise thou the Lord.

Glory be to the Father, and to the Son : and to the holy Ghost.

As it was in the beginning, and now, and ever : and for ever and ever. Amen.

Wee humbly implore, O merciful God, thy infinit clemency : that as we come to thee with a confident soule, and sincere faith, and a pious assurance of mind : with the like devotion thy beleevers may follow on these tokens of thy grace. May all superstition be banished hence, far be all suspicion of any diabolical fraud, and to the glory of thy name let all things succede : to the end thy beleevers may understand thee to be the dispenser of all good ; and may be sensible and publish, that whatsoever is profitable to soul or body, is derived from thee : through Christ our Lord. Amen.

These prayers being said, the king's highnes rubbeth the rings between his hands, saying :

Sanctify, O Lord, these rings, and graciously bedew them with the dew of thy benediction, and consecrate them by the rubbing of our hands, which thou hast been pleased according to our ministry to sanctify by an external effusion of holy oyle upon them ; to the end that what the nature of the mettal is not able to performe, may be wrought by the greatnes of thy grace : through Christ our Lord. Amen.

Then must holy water be cast on the rings, saying :

In the name of the Father, and of the Son, and of the holy Ghost. Amen.

O Lord, the only begotten Son of God, mediatur of God and men, Jesus Christ, in whose name alone salvation is sought for, and to such as hope in thee givest an easy access to thy Father ; who when conversing among men, thyself a man, didst promise by an assured oracle flowing from thy sacred mouth, that thy Father should grant whatever was asked in thy name ; lend a gracious care of pity to these prayers of ours : to the end that approaching with confidence to the throne of thy grace, the beleivers may find by the benefits conferrd upon them, that by thy mediation we have obtained, what we have most humbly beg'd in thy Name ; who livest and reignest with God the Father, in the unity of the holy Ghost, one God, for ever and ever. Amen.

Wee beseech thee, O Lord, that the Spirit, which procedes from thee, may prevent and follow on our desires ; to the end that what we beg with confidence for the good of the faithful, we may efficaciously obtaine by thy gracious gift : through Christ our Lord. Amen.

O most clement God ; Father, Son, and holy Ghost : wee supplicate and beseech Thee, that what is here performed by pious ceremonies to the sanctifying of thy name, may be prevalent to the defense of our soule and body on earth ; and profitable to a more ample felicity in heaven. Who livest and reignest God, world without end. Amen.

DR. JOHN WEYER AND THE WITCH MANIA

By E. T. WITHINGTON

THE value of every new truth or discovery is relative, and depends upon the state of ideas or knowledge prevalent at the time. Should it go greatly beyond this, it may lose much in practical effect, like good seed falling on unprepared soil; but the discoverer is no less worthy of praise though he be so far in advance of his fellows that they refuse to accept his teaching, and persecute instead of honouring him. Posterity, however, often ignores former conditions, especially in an era of rapid progress, for the quicker the advance the sooner will the early stages be forgotten, however important and difficult they may have been.

Among those who were so far beyond their age that the truths they proclaimed not only were rejected by the majority but brought them into danger was Dr. John Weyer, the first serious opponent of the witch mania. He stood almost alone. His attack on the witch-hunters, though it marks the turn of the tide, was followed by more than a century of cruelty, injustice, and superstition; yet our ideas on the subject are now so entirely altered that it is hard to imagine the value and danger of the service he performed, and his name was almost forgotten even by members of his own profession, when his biography was published by Dr. K. Binz in 1885.¹



¹ *Dr. Johann Weyer, der erster Bekämpfer des Hexenwahns*, Bonn, 1885, 2nd ed., Berlin, 1896. Also J. Geffcken, 'Dr. Johann Weyer' in *Monatshefte der Comenius*

Let us try to get some idea of the nature of the witch mania, that we may better appreciate the courage and intelligence of this ancient physician.

In the second half of the fifteenth century a new age began in Western Europe. The revival of Greek, the invention of printing, and the discovery of America gave fresh ideas and new prospects to mankind. But, as the sun's rays were believed to breed serpents in fermenting matter, so amid this ferment of new life and light rose a hideous monster, more terrible than any fabled dragon of romance or superstition of the darkest ages, which for generations satiated itself on the tears and blood of the innocent and helpless. This was the witch mania. For two centuries the majority of theologians and jurists in Western Europe were convinced that vast numbers of their fellow creatures, especially women, were in league with the devil, that they had sexual intercourse with him or his imps, and that he bestowed on them in exchange for their souls the power of injuring their neighbours in person or property. They thought it their duty to search out these witches, to force from them, by the most terrible tortures they could devise, not only confessions of their own guilt, but also denunciations of their associates, and finally to put them to death, preferably by burning. In consequence, many thousands of innocent persons of all ages and ranks, but especially poor women, were judicially murdered, after being first compelled by unspeakable torments to commit moral suicide by declaring themselves guilty of unmentionable crimes, and to involve their dearest friends and relations in a similar fate. There is no sadder scene in the whole tragicomedy of human history.

There had been nothing like it in the darkest of the dark ages, there was nothing like it among the far more ignorant and superstitious adherents of the Eastern Church. The witch mania in its extreme form has been manifested only by the Catholics and Protestants of the sixteenth and seventeenth centuries and by some tribes of African savages.

In early Christian times, witchcraft was recognized as a relic of paganism, but it was not feared. Christ had overcome the powers of darkness, and His true followers need fear no harm from them. A canon of the Church, at least as early as the ninth

Gesellschaft 3, 1904; J. Janssen and L. Pastor, *Geschichte des deutschen Volkes*, 8 vols., Freiburg im Breisgau, 1898-1903, viii. 600 ff.

century, declared that women who thought they rode through the air with Diana or Herodias were only deluded by the devil, and that those who believed human beings could create anything, or change themselves or others into animal forms, were infidels and worse than heathens; and confessors were instructed to inquire into and inflict penance for the belief that witches could enter closed doors, make hail-storms, or kill persons without visible means.¹

In the enlightened sixteenth century, any one who professed his disbelief that witches could ride through the air, change themselves into cats, or make caterpillars and thunder-storms, would have had an excellent chance of being burnt as a heretic or concealed sorcerer. St. Boniface (680–755) classed belief in witches and werewolves among the works of the devil, and St. Agobard of Lyons (779–840) declared the idea that witches caused hail and thunder-storms to be impious and absurd.² The laws of Charlemagne made it murder to put any one to death on charge of witchcraft, and in the eleventh century King Coloman of Hungary asserted briefly, ‘Let no one speak of witches, seeing there are none’.³ Few, indeed, were quite so sceptical as this; still witchcraft was in the Middle Ages looked upon by the educated in a half-contemptuous fashion, and even those who openly professed sorcery frequently escaped with no worse punishment than penance, banishment, or an ecclesiastical scourging.

This may be well illustrated by a story told in the life of the learned Dominican, St. Vincent of Beauvais. An old woman once (1190–1264) came to a priest in his church and demanded money from him, saying she had done him a great service, for that, when she and her companions, who were witches, had entered his bedroom the previous night, she had prevented them from injuring him. ‘But how’, asked the priest, ‘could you enter my chamber, seeing that the door was locked?’ ‘Oh,’ said the witch, ‘that matters naught to us, for we go through keyholes as easily as through open doors.’ ‘If what you say is true,’ replied the holy man, ‘you shall not lack a reward, but I must first have proof of it.’ With these words, he locked the church door, and began

¹ Jean Hardouin (Harduinus), *Collectio regia maxima conciliorum graecorum et latinorum*, 12 vols., Paris, 1715, i. 1506; H. C. Lea, *History of the Inquisition of the Middle Ages*, 2nd ed., 3 vols., London, 1906, iii. 494; W. G. Soldan and H. Heppe, *Geschichte der Hexenprocesse*, 2 vols., Stuttgart, 1880, i. 132.

² Lea, loc. cit., iii. 414.

³ Soldan and Heppe, loc. cit., i. 128, 139.

vigorously to beat the old woman with the handle of the crucifix he carried, asking her, when she complained, why she did not escape through the keyhole.¹

The great Pope Nicholas I (died 867) strongly condemned the use of torture to induce confessions, and Gregory VII (died 1085) forbade inquisition to be made for witches and sorcerers on occasions of plague or bad weather.² Later, the inquisitorial process, combined with torture to enforce denunciations, became the chief agent in spreading and maintaining the witch mania.

The Eastern Church remained in this mediæval stage, and never developed a witch mania. In the West the change seems to have been brought about mainly by two causes, the development of heresies and the increasing prominence of the devil.

There is no doubt that the Albigenian and other heresies of the twelfth and thirteenth centuries contained Manichean elements. It was taught that there were two divinities—one perfectly good, the creator of the invisible spiritual world, the other the creator of the material world, the Demiurgus, a being capable of evil passions, wrath, jealousy, &c., who was identified with the Jehovah of the Old Testament.³ It required very little to confound this Demiurgus with Satan, the Prince of this world; after which it was easy to look upon Satan as a being not entirely evil, as Lucifer, son of the morning, the disinherited son or brother of God, a natural object of worship for the oppressed and discontented.⁴

The serfs, equally tyrannized over by bishop and noble, the relics of the persecuted sects Waldenses and Cathari,⁵ sought refuge, like Saul of old, in forbidden arts, and thus sects of Luciferans, or devil-worshippers, arose (especially in Germany and France) whose numbers were exaggerated by the fear and horror of the orthodox.⁶

¹ See also Lea, loc. cit., iii. 434, on this mildness of the Church up to the fourteenth century.

² Soldan and Heppe, loc. cit., i. 136.

³ Lea, loc. cit., i. 91.

⁴ The Paulicians were accused of teaching that the devil created this world, but seem merely to have taken such texts as John xii. 31, xiv. 30; 2 Cor. iv. 4 'in their plain and obvious sense'. F. C. Conybeare, *Key of Truth, A Manual of the Paulician Church of Armenia*, Oxford, 1898, 46.

⁵ The term 'Cathari' was said to come 'from their kissing Lucifer under the tail in the shape of a cat'. Lea, loc. cit., iii. 495.

⁶ Lea, loc. cit., i. 105, ii. 334, &c. The main evidence is Conrad of Marburg's report to Pope Gregory XI, 1233: 'A tissue of inventions', but 'apparently doubted by no one'.

At the same time the devil acquired more importance in other ways. That fearful calamity, the Black Death, seemed to display his power over both the just and the unjust; while the Great Schism in which each pope excommunicated the other, handing him and his adherents over to Satan, put every one not absolutely certain of being on the right side in reasonable fear of the powers of darkness.

The belief in the great activity and power of the devil and his servants the sorcerers was further supported by the vast authority of St. Thomas Aquinas (1225-74), whose ingenuity enabled him to explain away those ancient canons which seemed opposed to the more extreme views. Thus the synod of Bracara (A. D. 563) had declared the doctrine that the devil can produce drought or thunder-storms to be heresy; to which the Doctor Angelicus replied that though it is doubtless heresy to believe the devil can make natural thunder-storms, it is by no means contrary to the Catholic faith to hold that he may, by the permission of God, make artificial ones.¹

For these and other reasons, the devil assumed greater prominence during the fourteenth and fifteenth centuries than ever before. Men believed that he might appear to them from behind every hedge or ruin, that his action was to be seen in almost all pains and diseases, but that he was to be dreaded most of all when he entered into a league with some man or woman. Thus everything was ready for the outbreak of witch mania when, in 1484, Pope Innocent VIII by his bull *Summis desiderantes* gave the sanction of the Church to the popular beliefs concerning witches, such as sexual intercourse with devils, destruction of crops, and infliction of sterility and disease on man and beast.

The charge of sorcery had usually been employed in earlier times either to check learned men who seemed to be going too far, or tending to heresy in their researches, as in the case of the physicians Arnold of Villanova (1240-1312) and Peter of Abano (1250-1320), or to crush individuals and societies who were politically dangerous, as with Joan of Arc, the Duchess of Gloucester, and the Templars—the Church being called in to aid the civil power. Now it was the Church which called upon the civil power to assist in a crusade against witches and sorcerers as being the worst and most dangerous of heretics.

¹ Quodlibet, xi. 10; Soldan and Heppe, loc. cit., i. 143; Lea, loc. cit., iii. 415.

In the Middle Ages it was held that a man who called up the devil, knowing it to be wrong, was not a heretic but merely a sinner. But if he thought it was not wrong, or that the devil would tell him the truth, or that the devil could do anything without God's permission, he was also a heretic, since these beliefs are contrary to Church doctrine. In the fifteenth century it was taught that all sorcerers are heretics, *maleficus* being, according to the learned authors of the *Malleus Maleficarum*, a contraction of *male de fide sentiens* or heretic.¹

Nor was the identification of heresy and witchcraft illogical, whatever we may think of the etymology. The Church is the kingdom of God, heretics form the kingdom of the devil, and just as the Church possesses saints who see visions, work miracles, and commune with Christ face to face, so there are specially eminent heretics, saints of the devil's church, who work miracles and have obscene intercourse with their master. All true Christians are potential saints, all heretics potential sorcerers, for all have committed treason against the divine Majesty, though only some may have entered into a definite compact with the enemy. The former, if they repent, may hope for perpetual imprisonment; the latter are to be put to death whether they repent or not.

This view was also of advantage to the Church, for it increased the horror of heresy and facilitated its suppression. The laity had never entirely reconciled themselves to the sight of their apparently harmless neighbours being tortured and burnt for differences in abstract belief, but almost every one was ready to torture and burn a sorcerer, and local outbreaks of witch-hunting were frequently started by mob violence. In 1555 it was declared by the Peace of Augsburg that no one should suffer in life and property for his religion; but to take a Lutheran, call him a sorcerer, confiscate his goods, and force him by torture to confess that he was led into his errors by the devil himself, seems to have been too great a temptation for the prince-bishops who headed the 'counter-reformation' in South Germany to resist. That this was partly the cause of the great witch-burnings in the bishoprics of Würzburg, Bamberg, Fulda, and Trèves is evidenced by the large proportion of male victims, and by the frequent and signi-

¹ H. Institoris and J. Sprenger, *Malleus Maleficarum*, editio princeps, Cologne, 1486, and frequently reprinted until the end of the seventeenth century. See especially pars 1, quaestio 2.

ficant appearance of the phrase 'is also Lutheran' in the official reports.

As soon as the Reformation was established, Protestants vied with Catholics as witch-hunters. Eager to show that they were in no way inferior to their opponents in zeal for the Lord and enmity against Satan and his servants, they had the advantage of being able to follow the scriptural injunction, 'Thou shalt not suffer a witch to live', without previously explaining away ancient canons and decrees of Church synods which seemed to throw doubt on the very existence of the more typical forms of witchcraft. Nor did they hesitate to attack their rivals with similar weapons. If Protestants were burnt as sorcerers at Würzburg, we find the first Danish Lutheran bishop, Peter Palladius, recommending the zealous members of his flock to seek out the so-called wise women of their neighbourhoods on pretence of having some disease. If then the latter use paternosters, holy water, or invocations of saints, they are probably not only Catholics but witches, and should be treated accordingly.¹

Almost all the victims of the witch mania were executed on their own confession, extorted in the vast majority of instances by torture or the fear of torture. In England, where torture was theoretically illegal, confessions were comparatively rare, and nearly all died protesting their innocence. The few exceptions prove the rule; thus Elinor Shaw and Mary Philips, almost the last witches legally executed in England, 1705, confessed because they were threatened with death if they refused, and promised release if they pleaded guilty,² while others were induced to admit their guilt by being kept awake several nights, and forced to run up and down their cells till utterly exhausted, methods almost as effectual in producing 'a readiness to confess' as the rack or the thumbscrew.³

Nearly all the confessions were to a similar effect. From Lisbon to Liegnitz, from Calabria to Caithness, the central point of the story was the 'sabbat', an assembly of witches and sorcerers in some barren spot where they adored a visible devil, indulged in

¹ J. Diefenbach, *Der Hexenwahn*, Mainz, 1886, p. 299.

² The story of Elinor Shaw and Mary Philips, as well as many other accounts of witchcraft, may be read in two volumes entitled *Rare and Curious Tracts illustrative of the History of Northamptonshire*, Northampton, 1876 and 1881.

³ F. Hutchinson, *Historical Essay*, London, 1718, cap. iv.

feasts, dances, and sexual orgies, reported what evil they had done and plotted more.

A few examples will therefore suffice, and they may be best taken from the *Daemonolatria*¹ of Nicholas Remy, Inquisitor of Lorraine, who burned nearly 900 witches and sorcerers in fifteen years, 1575-90.

He proves the reality of the witch dances as follows: 'A boy named John of Haimbach confessed that his mother took him to a sabbat to play the flute. He was told to climb up into a tree that he might be heard the better, and was so amazed by what he saw that he exclaimed: 'Good God! where did this crowd of fools and lunatics come from?' Thereupon he fell from the tree and found himself alone with a dislocated shoulder. Otilia Velvers, who was arrested soon after, confirmed the whole story, as did also Eysarty Augnel, who was burnt the following year. So too, Nicholas Langbernard, while going home in the early morning of July 21, 1590, saw in full daylight a number of men and women dancing back to back, some of them with cloven hoofs. He cried out 'Jesus' and crossed himself, upon which all vanished except a woman called Pelter, whose broomstick dropped, and who was then carried off by a whirlwind. The grass was afterwards found to be beaten down in a circle with marks of hoof-prints. Pelter and two other women were arrested and confessed they were present, as also did John Michael, who said he was playing the flute in a tree, and fell down when Nicholas crossed himself, but was carried off in a whirlwind, his broomstick not being at hand.

'What further evidence', asks the inquisitor, 'can any one require?' The only possible objection, viz. that they were phantoms or spirits of people whose bodies were asleep in their beds, is worthless, 'it being the pious and Christian belief that soul and body when once parted do not reunite till the day of judgement'.

The food at these sabbats usually included the flesh of unbaptized children, and was always abominable. A certain Morel said he was obliged to spit it out, at which the demon was much enraged. 'Dancing opens a large window to wickedness,' and is therefore specially encouraged by the devil, but the dances cause great exhaustion, just as his feasts cause loathing, and his money changes to dung or potsherds. 'Barberina Rahel, and nearly all others, declared they had to lie in bed two days after a witch dance,

¹ *Daemonolatriæ libri tres*, Lyons, 1595.

but even the oldest cannot excuse themselves, and the devil beats them if they are lazy.' The music is horrible; every one sings or plays what he likes, a favourite method being to drum on horse skulls or trees. Sometimes the devil gives a concert of his own, at which all are required to applaud and show pleasure; those who do not are beaten so that they are sore for two days, as Joanna Gransandeau confessed.

All are compelled to attend and give an account of their evil deeds under heavy penalties. C. G. said 'he was beaten till he nearly died for failing to attend a sabbat, and for curing a girl whom he had been told to poison. The devil also carried him up into the air over the river Moselle, and threatened to drop him unless he swore to poison a certain person.' The witch Belhoria was attacked by dropsy because she refused to poison her husband. If they failed in their attempts on others, they were compelled to poison their own children, or destroy their own property.

Antonius Welch was asked to lend his garden for a witch dance. He refused, and found it full of snails and caterpillars. Men of little faith have objected that only God can create, for 'without Him nothing is made that was made'; but why should not demons collect vast numbers of insects in a moment? Look at the well-known rain of frogs, blood, &c. This is doubtless done by devils out of mere sport: how much more would they do for love of harm? The making of thunder-storms is harder to believe, but has been admitted by more than 200 condemned witches and sorcerers. Almost all confessed that they could creep into locked rooms and houses in the form of small animals, and resuming their natural shape commit all sorts of crimes, showing, says Remy, what a peril they are to mankind.

A worthy comrade of Remy was Peter Binsfeld, suffragan Bishop of Trèves and foremost opponent of John Weyer. He is said to have burnt no fewer than 6,500 persons and to have so desolated his diocese that in many villages round Trèves there was scarcely a woman left. His *Tractatus de confessionibus maleficorum*¹ begins with the following case, which with those mentioned above affords a complete view of the usual witch confessions. John Kuno Meisenbein, a youth about eighteen years old, was studying 'poetry and the humaner letters' at the High School in Trèves, when he confessed to the authorities that his mother,

¹ Trèves, 1595.

brother, sister, and self were all in league with the devil. He said that in his ninth year his mother had initiated him as a sorcerer, and had carried him up the chimney on a goat to a heath near Trèves, where he took part in the usual sabbat and had intercourse with a female demon named Capribarba. The mother, Anna Meisenbein, a woman of good position, had already escaped to Cologne, but a son and daughter were arrested, strangled, and burned. 'They died with much sorrow and penitence.' The eldest son, John Kuno, thereupon urged the judges to use all means to capture his mother, 'that by punishment and momentary death in this world she might escape eternal damnation'.

Moved by this most creditable and merciful petition (*honestissima et plenissima misericordiae petitione excitatus*), the prior wrote to his friends at Cologne, and the unhappy woman was arrested and taken back to Trèves. At first she protested her innocence, 'but when more severe tortures were employed' she made the usual admissions. Having lost a baby, she had, for a moment, doubted the goodness of God. Whereupon a man in black raiment appeared at the side of the bed, and promised if she would renounce God and serve him he would give her peace of mind. She did so, and he became her lover, and gave her money, which however vanished. He called himself Fedderhans, and had asses' feet. Then follows the usual story of the sabbat. 'This woman', concludes the bishop, 'was burnt alive October 20, 1590, and had a good end.' They offered to behead John Kuno as a reward for his filial piety and repentance, but he said he was unworthy of such a favour and was therefore strangled and burnt. 'He had a most edifying end,' says the bishop, who proceeds to comment upon sexual intercourse between witches, sorcerers, and demons, 'which is so certain that it is an impudence to deny it, as St. Augustine saith,¹ being supported by the confessions of learned and unlearned, and by all the doctors of the Church, though a few medical men, advocates of the devil's kingdom [an obvious reference to Weyer, whom he abuses in the preface], have dared to deny it'.²

It is not our purpose to try and discover what amount of truth is contained in the immense farrago of absurdities comprised in the

¹ *Civ. Dei*, xv. 23.

² Peter Binsfeld, *Tractatus de confessionibus maleficorum*, Trèves, 1595, pp. 37-44, 230, &c. Binsfeld often refers to this case as proving the reality of disputed forms of witchcraft and the soul-saving work of the witch-hunters.

witch confessions. Actual nocturnal meetings of peasants, either to celebrate heathen rites or to plot against their oppressors, or merely to enjoy rude dances and music, as the negro in the Southern States was supposed to play the banjo nightly after his labours on the plantation, may or may not have assisted in spreading and confirming the belief in the sabbat, but they were not necessary. The whole story of child murder, obscene worship of a demon, dances and sexual orgies, was ready to hand long before. It had been applied in classic times to the worshippers of Isis and Bacchus, by the pagans to the early Christians, by the orthodox to the first heretics, to the Jews, to the Templars, and in our own day we have seen very similar charges brought against the Freemasons. All these sets of people had known meeting-places—the witches had none; they must therefore meet on some barren moor or mountain and be carried there supernaturally. Once started, the belief spread rapidly. Indeed we know from contemporary writers that it was a common subject of village gossip, and if any wretched victim had any doubt as to what she was expected to confess, the gaoler and judges were always ready with hints or leading questions.

One learned German¹ has attributed the whole witch mania to the *Datura Stramonium*, or thorn-apple, a plant introduced into Europe about this time. Women dosed themselves with this drug, or applied it in ointments, and forthwith had hallucinations of broomstick rides and witch dances. Others look upon belladonna as the principal agent, and one ardent investigator took dangerous doses of it in the hope of experiencing the adventures of a mediæval sorcerer, but without definite effect. A similar experiment has recently been made by Kiesewetter, the historian of 'Spiritualism'. He used the witch ointments described by Baptista Porta and others, but could produce nothing more diabolical than dreams of travelling in an express train.² Others, again, have supposed that the badly baked rye bread of the period must have produced an immense amount of nightmare among the poorer classes. The power of suggestion, doubtless, had a very real influence both on the victims and their judges, and with the aid of narcotics may not infrequently have produced vivid dreams of dancing and other intercourse with demons.

¹ L. Meyer, *Die Periode der Hexenprocesse*, Hannover, 1882.

² K. Kiesewetter, *Die Geheimwissenschaften*, Leipzig, 1895, p. 579 f.

No doubt many persons were quite ready to become witches or sorcerers, and some really believed they had acquired such powers. Cases are recorded in which formal agreements, duly signed in blood, and awaiting the devil's acceptance, were discovered, and resulted in the arrest and burning of the would-be wizard. Others took pleasure in the terror the reputed powers inspired, and may have sometimes caused or increased it by the use of actual poisons.

But these formed but a small minority of the vast army of victims; and even when some real criminal was arrested or some half-insane person voluntarily 'confessed', she was encouraged or compelled to denounce her supposed associates, and thus often involved scores of innocent acquaintances in her own awful fate.

The witch-hunters are not to be blamed for believing in witchcraft, or even for carrying out the scriptural injunction 'Thou shalt not suffer a witch to live'. It is the methods they employed, compared with which the procedure of a Jeffreys or a Caiaphas was just and merciful, which cannot be excused by any talk about the spirit of the age, which brought agony and death to many thousands of innocent men, women and little children, and which excited the fiery and righteous indignation of Dr. John Weyer.

According to Pascal, men never do wrong so thoroughly and so cheerfully as when they are obeying the promptings of a false principle of conscience. To which we may add that men are never more cruel and unjust than when they are in a fright. The witch-hunters, most of them at least, were pious and conscientious men. They appeal to God, the Church, and the Bible at every step. Nicholas Remy, for instance, after torturing and burning over 800 of his fellow creatures, retired from work thinking he had done God and man good service. But one thing troubled his conscience. He had spared the lives of certain young children, and merely ordered them to be scourged naked three times round the place where their parents were burning. He is convinced that this was wrong, and that they will all grow up into witches and sorcerers. Besides, if God sent two she-bears to slay the forty and two children who mocked Elisha, of how much greater punishment are those worthy who have done despite to God, His Mother, the saints, and the Catholic religion?¹ He hopes his sinful clemency will not become a precedent—a fear which was quite unnecessary, for scores

¹ *Op. cit.*, ii. 2 (p. 200).

of children under twelve were burnt for witchcraft ; and the one plea which even then respited the most atrocious murderess did not always avail a witch, since it was believed that her future child, if not the actual offspring of the devil, would infallibly belong to his kingdom.

But the witch-hunters were urged on by fear as well as by piety, for not only did they think themselves exposed to personal attacks from the devil and his allies, but they believed there was a vast and increasing society of men and women in league with the evil one, and that the fate of the world depended on its suppression.

All the machinery, therefore, which the Roman emperors had devised for their protection against treason and the Church for the suppression of heresy was brought into action against the witches, for witchcraft was the acme of treason and heresy, a *crimen laesae maiestatis divinae*.¹

For a description of the methods employed we cannot do better than go to the *Malleus Maleficarum*,² the guide and handbook of the witch-hunters.

All proceedings in cases of witchcraft, say the reverend authors, must be on the plan recommended by Popes Clement V and Boniface VIII, ' summarie, simpliciter, et de plano, ac sine strepitu ac figura iudicii ', a harmless looking phrase which swept away at a stroke all the safeguards which the lawyers of pagan Rome and the ruder justice of ancient Gaul and Germany had placed around accused persons. There are, says the *Malleus*,³ two forms of criminal procedure : (1) the old legal or *accusatorial* form where the prosecutor offers to prove his charge and to accept the consequences of failure, which must be carefully avoided as being dangerous and litigious ; and (2) the *inquisitorial*, where a man denounces another either from zeal for the faith, or because called upon to do so, but takes no further part nor offers to prove his charge, or where a man is suspected by common report and the judge makes inquiry, and this method must always be preferred. The inquisitors, on entering a new district, should issue a proclamation calling on all persons to give information against

¹ *Malleus*, pars i, quaestio 1, p. 6, edit. 1596.

² By H. Institoris and J. Sprenger. Between 1486 and 1596 several editions were printed in specially small form ' that inquisitors might carry it in their pockets and read it under the table '.

³ iii. 1 (p. 337 f.).

suspected witches on pain of excommunication and temporal penalties. Any one may be compelled, by torture if necessary, to give evidence, and if he refuses must be punished as an obstinate heretic. Other sorcerers, or the man's wife and family, are lawful witnesses against, but not for, the accused. Criminals and perjured persons, if they show zeal for the faith, may be admitted to give evidence. Priests, nobles, graduates of universities, and others legally exempt from torture are not exempt in the case of witch trials.¹

'Delation,' the scandal of imperial Rome, was not only encouraged but enforced, and in some places, as at Milan, boxes were put in the churches, into which any one might drop an anonymous denunciation of his neighbour.

Names of informers are not to be revealed under penalty of excommunication; the advocate, if there is one, need be told the charges only. This advocate must not be chosen by the accused but by the inquisitor, and he must refuse the case if it seems to him unjust or hopeless. He must not use legal quibbles or make delays or appeals, and is to be specially warned that if he be found a protector of heretics or a hinderer of the inquisition, he will incur the usual penalties for those heinous crimes. If he reply that he defends the person, not the error, this avails not, for he must make no defence which interferes with proceeding *summariè, simpliciter, et de plano*.² After this it is not surprising to find that those accused of witchcraft were rarely defended by an advocate.

Faith need be kept with heretics and sorcerers 'for a time only'.³ Therefore an inquisitor may promise not to condemn a person if he confesses, and then pass sentence after a few days, or if of very tender conscience by the mouth of another. It is also lawful to introduce persons, *etiam mulieres honestae*, to the accused who promise to find means for their escape if they will teach them some form of witchcraft. This, say the authors, is a most successful method for getting convictions.⁴

Torture, though it may not be repeated on the same charge, may be continued as long as necessary, and any fresh evidence justifies a repetition. Finally the accused may be burnt without confession if the evidence is strong enough, or he may be kept

¹ *Malleus*, iii. 4, p. 344.

³ iii. 14.

² iii. 10.

⁴ iii. 16.

in prison for months or years, when the *squalor carceris* may induce him to confess his crimes.¹

Such are the proceedings recommended against persons suspected of or denounced for witchcraft, and they conclude appropriately with the hideously hypocritical formula with which they were delivered over to be burnt: 'Relinquimus te potestati curiae secularis, deprecantes tamen illam ut erga te citra sanguinis effusionem et mortis periculum suam sententiam moderetur',² which means, according to the *Malleus*, that sorcerers are to be burned even though they repent, while repentant heretics may be imprisoned for life.

What was meant by the *squalor carceris* may be seen from the following description by an eye-witness, Pretorius:³

'Some [of the dungeons] are holes like cellars or wells, fifteen to thirty fathoms (?) deep with openings above, through which they let down the prisoners with ropes and draw them up when they will. Such prisons I have seen myself. Some sit in great cold, so that their feet are frost-bitten or frozen off, and afterwards, if they escape, they are crippled for life. Some lie in continual darkness, so that they never see a ray of sunlight, and know not whether it be night or day. All of them have their limbs confined so that they can hardly move, and are in continual unrest, and lie in their own refuse, far more filthy and wretched than cattle. They are badly fed, cannot sleep in peace, have much anxiety, heavy thoughts, bad dreams. And since they cannot move hands or feet, they are plagued and bitten by lice, rats, and other vermin, besides being daily abused and threatened by gaolers and executioners. And since all this sometimes lasts months or years, such persons, though at first they be courageous, rational, strong, and patient, at length become weak, timid, hopeless, and if not quite, at least half idiotic and desperate.'

Yet all this was not considered torture, and if some poor wretch, after a year of it, went mad, or preferred a quick death to a slow one, her confession was described as being 'entirely voluntary and without torture'.

As to the torture itself, it combined all that the ferocity of savages and the ingenuity of civilized man had till then invented. Besides the ordinary rack, thumb-screws, and leg-crushers or Spanish boots, there were spiked wheels over which the victims were drawn with weights on their feet; boiling oil was poured on

¹ iii. 14.

² iii. 29-31, repeated with slight variations.

³ *Von Zauberei und Zauberern*, p. 211; Soldan and Heppe, i. 347.

their legs, burning sulphur dropped on their bodies, and lighted candles held beneath their armpits. At Bamberg they were fed on salt fish and allowed no water, and then bathed in scalding water and quicklime. At Lindheim they were fixed to a revolving table and whirled round till they vomited and became unconscious, and on recovery remained in so dazed a state that they were ready to confess anything.¹ At Neisse they were fastened naked in a chair 'with 150 finger-long spikes in it' and kept there for hours. And so effective were these tortures that nine out of ten innocent persons preferred to die as confessed sorcerers rather than undergo a repetition of them.

The Jesuit Father Spee, a worthy successor of John Weyer, accompanied nearly two hundred victims to the stake at Würzburg in less than two years. At the end of this time his hair had turned grey and he seemed twenty years older, and on being questioned as to the cause, declared that he was convinced that all these persons were innocent. They had, he said, at first repeated the usual confession, but on being tenderly dealt with had one and all protested their innocence, adjuring him at the same time not to reveal this, for they would much rather die than be tortured again. He added that he had received similar reports from other father confessors.² A few years later, 1631, he plucked up courage to publish anonymously his *Cautio Criminalis*, in which he exclaims :

'Why do we search so diligently for sorcerers? I will show you at once where they are. Take the Capuchins, the Jesuits, all the religious orders, and torture them—they will confess. If some deny, repeat it a few times—they will confess. Should a few still be obstinate, exorcise them, shave them: they use sorcery, the devil hardens them, only keep on torturing—they will give in. If you want more, take the Canons, the Doctors, the Bishops of the Church—they will confess. How should the poor delicate creatures hold out? If you want still more, I will torture you and then you me. I will confess the crimes you will have confessed, and so we shall all be sorcerers together.'³

¹ The Lindheim cases are recorded by G. C. Horst, afterwards pastor of the place, in his *Dämonologie*, 2 vols., Frankfort, 1818, and *Zauberbibliothek*, 6 vols., Mainz, 1821-6. See also O. Glaubrecht, *Die Schreckensjahre von Lindheim*, 1886.

² *Cautio Criminalis*, Rinteln, 1631, *Dubium* xix (p. 128). He calls himself 'Sacerdos quidam'.

³ *Dubium* xx (p. 153).

In the most notorious of judicial murders, we read that the judges had some difficulty owing to a disagreement between the witnesses. This rarely troubled the witch-hunters. At Lindheim a woman was accused of having dug up and carried off the body of an infant, which, under torture, she admitted, denouncing four others as her accomplices. But on the grave being opened, the body was found uninjured. The inquisitors at once decided that this must be a delusion of the devil, and all five women were burned. A man confessed, under torture, that he was a werewolf, and in that form had killed a calf belonging to a neighbour; the latter, however, said he had never lost a calf, though two or three years ago two hens had disappeared, he believed through witchcraft. The accused was burnt, for what need had they of witnesses? Had they not heard his confession?¹

It was even laid down as a principle that doubtful points must be decided 'in favour of the faith'—in other words, against the accused. 'If a sorcerer retracts his denunciations at the stake, it is not void, for he may have been corrupted by friends of the accused. Also when witnesses vary, as they often do, the positive assertion is always to be believed,' says Bishop Covarivias, a prominent member of the Council of Trent. In which he is supported by the jurist Menochius of Padua, 'ne tam horrendum crimen occultum sit'.

Anything might start a witch-hunting, and once started it increased like an avalanche. If an old woman happened to be out of doors in a thunder-storm; if the winter was prolonged; if there was a more than usual number of flies and caterpillars; if a woman had a spite against her neighbour, some one might be denounced and forced in turn to denounce others. The prolonged winter of 1586 in Savoy, for instance, resulted in the burning of 113 women and two men, who confessed, after torture, that it was due to their incantations.

It is thus not difficult to understand how, in the diocese of Como, witches were burnt for many years at an average rate of 100 per annum; how in that of Strassburg 5,000 were burnt in twenty years, 1615-35; how in the small diocese of Neisse 1,000 suffered between 1640-50, insomuch that they gave up the stake and pile as being too costly, and roasted them in a specially prepared oven; and how the Protestant jurist Benedict Carpzov could boast not

¹ Horst, *Zauberbibliothek*, ii. 374, and *Dämonomagie*, ii. 412.

only of having read the Bible through fifty-three times, but also of having passed 20,000 death sentences, chiefly on witches and sorcerers.¹

One of Carpzov's victims is specially interesting to medical men, the Saxon physician, Dr. Veit Pratzel, who on one occasion (1660) produced twenty mice by sleight of hand in a public-house, probably for the sake of advertisement. He was denounced as a sorcerer, tortured and burnt, while his children were bled to death in a warm bath by the executioner, lest they should acquire similar diabolical powers.²

A like fate befell the servant of a travelling dentist at Schwersenz in Poland. The dentist, John Plan, left his assistant in the town to attract attention by conjuring tricks, while he went to sell his infallible toothache tinctures in the neighbouring villages. On his return next evening, he was horrified to see the body of the unfortunate man hanging on the town gallows, and was told on inquiry that he was an evident sorcerer who had made eggs, birds, and plants before everybody in the market-place. He had therefore been arrested, scourged, put on the rack, and otherwise tortured till he confessed he was in league with the devil. Whereupon the town council, 'out of special grace and to save expense', had, instead of burning him, mercifully condemned him to be hanged. The dentist fled in terror to Breslau.³

But it was by no means necessary to be so foolhardy as this to fall into the hands of the witch-hunters. A woman at Lindheim was noticed to run into her barn as the inquisitorial officials came down the street. She had never been accused or even suspected of witchcraft, but was nevertheless immediately arrested, and brought more dead than alive to the chief inquisitor, Geiss,⁴ who declared her flight justified the strongest suspicion. Exposed to the most extreme torture, she confessed nothing, but at length, at the question whether she had made a compact with the devil, one of the inquisitors declared he saw her nod her head. This was enough; she was burnt; probably a happy fate under the circumstances, for she thus escaped being forced by further tortures to give details of her imaginary crime and to denounce her neighbours.

¹ Soldan and Heppe, ii. 209.

² Soldan and Heppe, ii. 130.

³ J. H. Böhmer, *Ius ecclesiasticum*, 5 vols., Halle, 1738-43, v. 35.

⁴ Horst, *Dämonomagie*, ii. 377.

Once in the clutches of the witch-hunters, the unfortunate victim was confronted by a series of dilemmas from which few escaped. A favourite beginning was to ask whether he believed in witchcraft. If he said 'Yes', he evidently knew more of the subject; if 'No', he was *ipso facto* a heretic and slanderer of the inquisition; if in confusion he tried to distinguish, he was *varius in confessionibus*,¹ and a fit subject for immediate torture. If he confessed under torture, the matter was, of course, settled; if he endured manfully, it was evident that the devil must be aiding him. If a mark could be found on his body which was insensible and did not bleed when pricked, it was the devil's seal and a sure sign of guilt; but if there was none, his case was no better, for it was held that the devil only marked those whose fidelity he doubted, so that a suspected person who had no such mark was in all probability a specially eminent sorcerer.²

Then came the water test, of which there is no better account than the report sent by W. A. Scribonius, Professor of Philosophy at Marburg, to the town council of Lemgo in 1583:

'When I came to you, most prudent and learned consules, 26th September, there were, two days later on St. Michael's eve, three witches burnt alive for divers and horrible crimes. The same day three others, denounced by those aforesaid, were arrested, and on the following day about 2 p.m. for further proving of the truth were thrown into water to see whether they would swim or not. Their clothes were removed and they were bound by the right thumb to the left big toe and vice versa, so that they could not move in the least. They were then cast three times into the water in the presence of some thousands of spectators, and floated like logs of wood, nor did one of them sink. And it is also remarkable that almost at the moment they touched the water a shower of rain then falling ceased, and the sun shone, but when they were taken out it started raining as before.'

On request of the burgomaster, he investigated 'the philosophy' of this, and, though he could find nothing definite, had no doubt of its value as a test of witchcraft. 'The physician Weyer rejects it as absurd and fallacious, but he can produce no good arguments or examples against it, and may therefore be ignored.' Perhaps witches are made lighter because possessed by demons who are 'powers of the air' and often carry them

¹ *Malleus*, iii. 14 (p. 370).

² Father Spee gives a long list of these dilemmas, *Cautio Criminalis*, Dubium li.

through the air. All who float have afterwards confessed, therefore though not scriptural nor of itself sufficient to convict, the swimming test is not to be despised.¹

With regard to the number of victims, even sober historians, such as Soldan, speak of millions, but if we take three-quarters of a million for the two centuries 1500–1700, it will give a rate of ten executions daily, at least eight of which were judicial murders.

Even more pathetic than the notice of 800 condemned in one body by the senate of Savoy² are the long lists of yearly executions preserved in the fragmentary records of small towns and villages. Thus at Meiningen, between 1610–31 and 1656–85, 106 suffered—in 1610 three, 1611 twenty-two, 1612 four, &c. &c., the intervening records being omitted owing to war. Similar notices have survived at Waldsee, Thun in Alsace, and many other hamlets, where through a long series of years we read of one to twenty persons burnt annually, some of them being previously ‘torn with red-hot pincers’.³

At Würzburg the Prince-bishop, Philip of Ehrenberg, is said to have burnt 900 in five years (1627–31), and we have terrible lists of twenty-nine of the burnings, almost all of which include young children. Here are two of them :

‘In the thirteenth burning, four persons : the old court smith, an old woman, a little girl of nine or ten years, a younger girl her sister.’

‘In the twentieth burning, six persons : Babelin Goebel, the prettiest girl in Würzburg ; a student in the fifth form who knew many languages and was an excellent musician, instrumental and vocal ; two boys from the new minster, twelve years old ; Babel Stepper’s daughter ; the caretaker on the bridge.’⁴

At Bamberg the Prince-bishop, John George, 1625–30, burnt at least 600 persons, and his predecessors had been hardly less vigorous witch-hunters. He was ably seconded by his suffragan, Bishop Förner, and two doctors of law, Braun and Kötzendörffer, who besides the ordinary torture implements, salt fish and quick-lime baths, found a so-called prayer stool or bench covered with

¹ *De sagarum natura et potestate, deque his recte cognoscendis et puniendis deque purgatione earum per aquam frigidam epistola*, Lemgo, 1583. Also in Sawr, *Theatrum de Veneficiis*, 1856.

² Lea, iii. 549.

³ Haas, *Die Hexenprocesse*, Tübingen, 1865.

⁴ Soldan and Heppel, ii. 46, and elsewhere.

spikes, on which the victim was forced to kneel, and a cage with a sharp ridged floor on which he could not stand, sit, or lie without torment, of great value in extorting confessions. The record of their deeds has been published by Dr. F. Leitschuh,¹ librarian of Bamberg, and contains, among other cases, that of the Burgomaster, John Junius, which throws more light on the nature of the witch trials than do volumes of second-hand history.²

John Junius, a man universally respected, had been five times Burgomaster of Bamberg, and held that office in June 1628, when he was arrested on a charge of sorcery. He protested his innocence though six witnesses declared, under torture, that they had seen him at the witch dances. On June 30 he endured the torment of the thumb-screws and leg-crushers (Spanish boots) without confession. Then they stuck pins in him and found a 'devil's mark', and finally drew him up with his arms twisted backwards, but he would admit nothing. Next day, however, when threatened with a repetition of the torture, he broke down, made the usual confession (including intercourse with a female demon who turned into a he-goat), and denounced twenty-seven persons whose names and addresses are given.³ He was condemned to be beheaded and burnt, but before his death wrote the following letter to his daughter :

'Many hundred thousand good-nights, my dearest daughter Veronica! Guiltless was I taken to prison, guiltless have I been tortured, guiltless I must die. For whoever comes here must either be a sorcerer, or is tortured until (God pity him) he makes up a confession of sorcery out of his head. I'll tell you how I fared. When I was questioned the first time, there were present Dr. Braun, Dr. Kötzendörffer, and two strangers. Dr. Braun asked me, "Friend, how came you hither?" I answered, "Through lies and misfortune." "Hear you," said he, "you're a sorcerer. Confess it willingly or we'll bring witnesses and the executioner to you." I said, "I am no sorcerer. I have a clear conscience on this matter, and care not for a thousand witnesses, but am ready to hear them." Then the chancellor's son, Dr. Haan, was brought out. I asked, "Herr Doctor, what do you know of me? I never had anything to do with you, good or bad." He answered, "Sir, it is a judgement matter, excuse me for witnessing against you. I saw you at the dances." "Yes, but how?" He did not know. Then I asked the commissioners to put him on oath, and examine him properly.

¹ *Beiträge zur Geschichte des Hexenwesens in Franken*, Bamberg, 1883.

² 48 ff.

³ Official report, given by Leitschuh in appendix.

"The thing is not to be arranged as you want it," said Dr. Braun; "it is enough that he saw you." I said, "What sort of witness is that? If things are so managed, you are as little safe as I or any other honourable person." Next came the chancellor and said the same as his son. He had seen me, but had not looked carefully to see who I was. Then Elsa Hopffen. She had seen me dancing on Haupt's moor. Then came the executioner and put on the thumb-screws, my hands being tied together, so that the blood spurted from under the nails, and I cannot use my hands these four weeks, as you may see by this writing. Then they tied my hands behind and drew me up. I thought heaven and earth were disappearing. Eight times they drew me up and let me fall so that I suffered horrible agony. All which time I was stark naked, for they had me stripped.

'But our Lord God helped me, and I said to them, "God forgive you for treating an innocent man like this; you want not only to destroy body and soul, but also to get the goods and chattels." [At Bamberg, two-thirds of the property of convicted sorcerers went to the bishop, and the rest to the inquisitors.] "You're a rascal," said Dr. Braun. I replied, "I am no rascal, but as respectable as any of you; but if things go on like this, no respectable man in Bamberg will be safe, you as little as I or another." The doctor said he had no dealings with the devil. I said, "Nor have I. Your false witnesses are the devils, your horrible tortures. You let no one go, even though he has endured all your torments."

'It was Friday, 30th June, that, with God's help, I endured these tortures. I have ever since been unable to put my clothes on or use my hands, besides the other pains I had to suffer innocently.

'When the executioner took me back to prison, he said to me, "Sir, for God's sake confess something, whether true or not. Think a little. You can't stand the tortures they'll inflict on you, and even if you could you wouldn't escape, though you were a count, but they'll go through them again and again and never leave you till you say you are a sorcerer, as may be seen by all their judgements, for all end alike." Another came and said the bishop had determined to make an example of me which would astonish people, and begged me for God's sake to make up something, for I should not escape even though I were innocent, and so said Neudecker and others.

'Then I asked to see a priest, but could not get one. . . . And then this is my confession as follows, but all of it lies.

'Here follows, dearest child, what I confessed that I might escape the great torments and agonies, for I could not have endured them any longer. This is my confession, nothing but lies, that I had to make on threat of still greater tortures, and for which I must die.

“I went into my field, and sat down there in great melancholy, when a peasant girl came to me and said, ‘Sir, what is the matter? Why are you so sorrowful?’ I said I did not know, and then she sat down close to me, and suddenly changed into a he-goat and said, ‘Now you know with whom you have to do.’ He took me by the throat and said, ‘You must be mine, or I’ll kill you.’ Then I said, ‘God forbid.’ Then he vanished and came back with two women and three men; bade me deny God, and I did so, denied God and the heavenly host. Then he baptized me and the two women were sponsors; gave me a ducat, which turned into a potsherd.”

‘Now I thought I had got it over, but they brought in the executioner, and asked where I went to the witch dances. I did not know what to say, but remembered that the chancellor and his son and Elsa Hopffen had mentioned Haupt’s moor and other places, so I said the same. Then I was asked whom I had seen there. Replied I did not recognize any. “You old rascal, I must get the executioner to you. Was the chancellor there?” Said “Yes.” “Who else?” “I recognized none.” Then he said, “Take street by street, beginning from the market.” Then I had to name some persons. Then Long Street. I knew nobody; had to name eight persons. . . . Did I know any one in the castle? I must speak out boldly whoever it was. So they took me through all the streets till I could and would say no more. Then they gave me to the executioner to strip, shave off my hair, and torture me again. “The rascal knows a man in the market-place, goes about with him daily, and won’t name him.” They meant Dietmeyer, so I had to name him.

‘Next they asked what evil I had done. I replied, “None.” The devil bade me to, and beat me when I refused. “Put the rascal on the rack.” So I said I was told to murder my children but killed a horse instead. That wasn’t enough for them. I had also taken a sacramental wafer and buried it. When I said this they left me in peace.

‘There, dearest child, you have all my confession, for which I must die, and it is nothing but lies and made-up things, so God help me. For I had to say all this for fear of the tortures threatened me, besides all those I had gone through. For they go on torturing till one confesses something; be he as pious as he will, he must be a sorcerer. No one escapes, though he were a count. And if God does not interfere, all our friends and relations will be burnt, for each has to confess as I had.

‘Dearest child, I know you are pious as I, but you have already had some trouble, and if I may advise, you had better take what money there is and go on a pilgrimage for six months, or somewhere where you can stay for a time outside the diocese till one sees what

will happen. Many honourable men and women in Bamberg go to church and about their business, do no evil, and have clear consciences as I hitherto, as you know, yet they come to the witch prison, and if they have a tongue to confess, confess they must, true or not.

‘Neudecker, the chancellor, his son, Candelgiesser, Hofmeister’s daughter, and Elsa Hopffen all denounced me at once. I had no chance. Many are in the same case, and many more will be, unless God intervenes.

‘Dear child, keep this letter secret so that nobody sees it, or I shall be horribly tortured and the gaoler will lose his head, so strict is the rule against it. You may let Cousin Stamer read it quickly in private. He will keep it secret. Dear child, give this man a thaler.

‘I have taken some days to write this. Both my hands are lamed. I am in a sad state altogether. I entreat you by the last judgement, keep this letter secret, and pray for me after my death as for your martyred father . . . but take care no one hears of this letter. Tell Anna Maria to pray for me too. You may take oath for me that I am no sorcerer, but a martyr.

‘Good-night, for your father, John Junius, will see you never more.

24th July, 1628.’

On the margin is written :

‘Dear child, six denounced me: the chancellor, his son, Neudecker, Zaner, Ursula Hoffmaister, and Elsa Hopffen, all falsely and on compulsion as they all confessed. They begged my pardon for God’s sake before they were executed. They said they knew nothing of me but what was good and loving. They were obliged to name me, as I should find out myself. I cannot have a priest, so take heed of what I have written, and keep this letter secret.’

The letter is still preserved, with its crippled handwriting, in the library at Bamberg. This case is beyond comment. It is like the trial of Faithful at Vanity Fair, but with rack and thumb-screw in place of a jury. Yet it is but a moderate sample of those outrages on justice and humanity called witch trials. Men rarely held out long, but, did space permit, we might tell stories of many heroic women who endured ten, twenty, even fifty repetitions of torture, till they died on the rack or in the dungeon rather than falsely accuse themselves or their neighbours.¹

¹ Maria Hollin at Nördlingen (1593) withstood fifty-six repetitions of torture, and was finally ‘dismissed’ on the terms mentioned (Janssen, *op. cit.*, viii. 719).

For when once arrested, the victim had small hope of acquittal, and in the most favourable cases, when there was no external evidence, and no amount of torture could induce a 'confession', the accused was sent back friendless and crippled to her home, which she was forbidden to leave, having first sworn to have no more dealings with the devil, and to take no proceedings against her accusers. To acquit her would imply that an innocent person had been tortured, a thing naturally repugnant to the tender consciences of the inquisitors.

Nor was the mania confined to any special class. Protestants vied with Catholics, and town councils with bishops in cruelty and injustice. At Nördlingen they had a special set of torture instruments which the Protestant town council lent to neighbouring district authorities, with the pious observation that 'by these means, and more especially by the thumb-screw, God has often been graciously pleased to reveal the truth, if not at first, at any rate at the last'.¹

It is obvious from the above cases that the main cause of the continuance of the witch-burnings, and of the number of the victims, was the use of torture to obtain denunciations. The instances in which insane persons accused themselves or others seem to have been fewer than we might have expected.

Then, as now, there were melancholics who thought they had committed the unpardonable sin, and in those days the unpardonable sin might be represented by an imaginary compact with the devil. Then, as now, the 'mania of persecution' was a prominent symptom in some forms of insanity, and the idea of being bewitched by some old woman corresponded to the modern dread of detectives, electric batteries, or telephones.

Some of the supposed signs of witchcraft resemble those of mania and melancholia. Thus maniacs sometimes collect dirt for money, and witches often confessed that the devil's money changed to dirt. Melancholics mutter to themselves, look on the ground, and avoid society, all of which were considered signs of witchcraft. But then red hair and left-handedness were no less infallible indications.

Insanity and crime were indeed present at the witch trials, but they were at least as obvious in the accusers and judges as in the

¹ The Nördlingen authorities acquired an evil eminence in this frightfulness, which they termed 'eine heilsame Tortur' (Soldan, ii. 470).

victims, and the first man who was bold enough to say so was Dr. John Weyer. Though a few feeble protests may have been made by others, it was from the medical profession that the first determined opposition came. Mystics like Paracelsus and Cardan might encourage the superstition; pious and able members of the profession like Ambroise Paré and Sir Thomas Brown might give it their sanction, but it was the physician Cornelius Agrippa who first successfully defended a witch at the risk of his own life,¹ and it was his pupil John Weyer who first declared open war against the witch-hunters and invoked the vengeance of heaven upon their atrocities.

‘The feareful abounding at this time in this countrie of those detestable slaves of the divell, the witches or enchanters hath moved me (beloved reader) to dispatch in post the following treatise of mine, not in any wise (as I protest) to serve for a shewe of my learning and ingine, but only (moved of conscience to preasse thereby) so far as I can, to resolve the doubting hearts of manie both that such assaults of Satan are most certainly practised, and that the instruments thereof merit most severely to be punished, against the damnable opinions of two principally in our age, whereof the one called Scot, an Englishman, is not ashamed in public print to denie that there can be such a thing as witchcraft and so maintains the old error of the Sadduces in denying of spirits, the other called Wierus, a German physition sets out a publike apologie for all these crafts-folks, whereby procuring for their impunity, he plainly bewrayes himself to have been of that profession.’

Thus did our ‘British Solomon’, James I, commence his *Dæmonologia* (1598), a work directed against the two men who alone up to that time had made a bold and open protest against the witch mania and its abominations. Reginald Scot in his *Discovery of Witchcraft* (1584) took the view of a modern common-sense Englishman, that the whole thing is absurd, a mixture of roguery and false accusations. Weyer, on the other hand, his predecessor by twenty years, is a firm believer in the activity of the devil, whose object, however, is not to get possession of the souls of crazy old women, but by deluding them, to convert pious and learned lawyers and theologians into torturers and murderers.

Born about 1516 at Grave in Brabant, the son of a dealer in hops and faggots, Weyer was acquainted with the supernatural

¹ Lea, iii. 545, and references there given.

from his earliest years, for they had a domestic 'house cobold' or *Poltergeist*, who was heard tumbling the hop-sacks about whenever a customer was expected. At seventeen years of age the boy was sent to study medicine as apprentice to Cornelius Agrippa, an extraordinary man, long held to be a sorcerer, who had recently incurred yet stronger suspicion by his heroic and successful defence of a woman accused of witchcraft at Metz, and by his fondness for a black dog called 'Monsieur' which scarcely ever left him. The young Weyer used to take this animal out on a string, and soon became convinced, to use his own words, that it was 'a perfectly natural male dog'.¹ He next went to Paris and thence to Orleans, a university then famous for its medical school, where he took the degree of M.D. in 1537. He commenced practice in Brabant, became public medical officer at Arnheim in 1545, and in 1550 physician to Duke William of Cleves. In 1563 he published his great work *De praestigiis daemonum et incantationibus ac veneficiis*,² the object of which is to show that so-called witchcraft is usually due to delusions of demons, who take advantage of the weaknesses and diseases of women to bring about impious and absurd superstitions, hatreds, cruelties, and a vast outpouring of innocent blood, things in which they naturally delight.

He proposes to treat the subject under four heads corresponding to the four faculties, theology, philosophy, medicine, and law. In the first section he attempts to show that the Hebrew word *Kasaph* does not mean 'witch' but 'poisoner', or at any rate that Greek, Latin, and Rabbinical interpreters so vary, that no reliance can be placed upon them. Moreover the law of Moses was given to the Jews 'for the hardness of their hearts', and is by no means always to be used by Christians.³ Magicians and sorcerers do indeed still exist, as in ancient Egypt, but these are always men, and usually rogues and swindlers, such as was Faust, of whom Weyer gives us one of the earliest and most authentic notices. Faust, he says, was once arrested by Baron Hermann of Batoburg, and given in charge of his chaplain, J. Dursten, who hoping to see some sign or wonder, treated him with much kindness, giving him the best of wine. But all he got out of him was a magic ointment to enable him to shave without a razor, containing arsenic, and so strong that it brought

¹ *De praestigiis, &c.*, ii. 5.

² The privilege for publication is dated November 4, 1562; three editions appeared before the end of 1564, and a sixth in 1583.

³ *Op. cit.*, ii. 1.

not only the hair but the skin from the reverend gentleman's cheeks. 'The which he has told me more than once with much indignation.'¹

Weyer, however, firmly believes that the devil may assist sorcerers, such as Faust, in some of their feats, though he does this chiefly by deluding the eyes of the spectators. He may also delude women into the belief that they have been at witch dances and caused thunder-storms, &c., but his greatest deception is to make men believe in the reality of witchcraft and so torture and murder the innocent.² Women are more liable to his deceptions owing to their greater instability both of mind and body, and the delusion may be favoured by the use of drugs and ointments, especially those containing belladonna, lolium, henbane, opium, and even more by herbs recently introduced from east and west, such as Indian hemp, datura, 'and the plant called by the Indians "tabacco", by the Portuguese "peto", and by the French "nicotiana"'.³

As for the supposed compact with the devil, it is an absurdity only surpassed by the belief in sexual intercourse with demons. This delusion, Weyer points out, may be explained medically by the phenomena of nightmare and the effects of certain drugs, and is not sanctioned by Scripture. For, though holy men such as Lactantius, Justin Martyr, and Tertullian have maintained that the 'sons of God' mentioned in Genesis vi. 2 were spirits, this interpretation is opposed by still more eminent theologians, such as Saints Jerome, Gregory Nazianzen, and Chrysostom, though he is obliged to admit that St. Augustine believed in *incubi* and *succubae*,⁴ and that distinguished living theologians hold that Luther's father was literally the devil. This, however, says Weyer, is an unfair and prejudiced way of attacking the Lutheran heresy.⁵

People who fancy themselves bewitched are really possessed or assaulted by the devil, as were Job and the demoniacs of the New Testament. If these demoniacs had lived in our days, he remarks, they would probably have each cost the lives of numerous old women.⁶ The strange objects vomited by such persons are either deceptions or put into the person's mouth by the devil, as is shown by there being no admixture of food, and the absence of pain or injury in spite of the size of the objects.⁷

¹ Op. cit., ii. 4.

² iii. 6.

³ iii. 18.

⁴ iii. 21.

⁵ iii. 23.

⁶ iv. 1.

⁷ iv. 2.

A girl near Cleves fell into convulsions with clenched hands and teeth which, according to her father, could only be opened by making the sign of the cross. She also complained of pains for which it was necessary to buy a bottle of holy water from a priest at Amersfort, on drinking which she proceeded to vomit pins, needles, scraps of iron, and pieces of cloth. She spoke in an altered boyish voice, intended for that of a demon, and declared the whole was caused by an 'in my opinion honest matron', who was imprisoned with her mother and two other women.

Weyer undertook the case, 'whereupon she said in her boy's voice she would have nothing to do with me, and that I was a cunning fellow. "Look what sharp eyes he has."' Weyer opened her hands and mouth, without making the sign of the cross, 'not that I would in any way speak irreverently thereof'. He also showed that the objects produced, even soon after eating, were free from admixture of food, and had therefore never been farther than the mouth; and he thus obtained the release of the four women after a month's imprisonment.¹

As for the stories of men changed into animals, they are partly poetic and moral allegories, as the sailors of Ulysses, and partly a form of insanity long recognized by physicians, and termed lycanthropy.²

Many think they are possessed when they are only melancholic, and others pretend to be so to excite interest and obtain money. Those who fancy themselves attacked by devils should, instead of accusing their neighbours, take to themselves the armour of God as described by St. Paul. Unfortunately, spiritual pastors, in their ignorance and greed, teach that not only diabolical possession, but even ordinary diseases are to be cured by charms, incantations, palm branches, consecrated candles, and an execrable abuse of scriptural words. Cures are, indeed, sometimes so produced, but are really due to the imagination.

Persons supposed to be possessed should first be taken to an intelligent physician, who should investigate and treat any bodily disorder. Should spiritual disorders be also present he may then send the patient to a pious minister of the Church, but this will often be unnecessary. The devil is especially fond of attacking nuns, who should be separated from the rest, and, if possible, sent home to their relations.³

¹ iv. 3.² iv. 23.³ iv. 10.

Here Weyer inserts several instances in his own experience.

Philip Wesselich, a monk of Knechtenstein near Cologne, an honest, simple-minded man, was miserably afflicted by a spirit about the year 1550. Sometimes he was carried up to the roof, at others thrust in among the beams of the belfry, often carried unexpectedly through the wall (*plerumque per murum transferebatur inopinato*) and knocked about generally. At length the spirit declared he was Matthew Duren, a former abbot, condemned to penance for having paid an artist insufficiently for a painting of the Blessed Virgin, so that the poor man went bankrupt and committed suicide, 'which was true'. He could only be released if the monk went to Trèves and Aix and recited three masses in the respective cathedrals. The theological faculty of Cologne advised that he should do so, but the abbot Gerard, a man of firmness and intelligence, told the possessed man that he was a victim of diabolical deceptions, and that unless he put his trust in God, and pulled himself together, he should be publicly whipped. Whereupon the monk did so, and the devil left him and went elsewhere.¹

A similar case was that of a young woman known to Weyer, who had convulsions in church whenever the 'Gloria in excelsis' was sung in German, and said she was possessed. It was observed, however, that she looked about for a soft place to fall on. She was therefore sent for by Weyer's friend the Countess Anna of Virmont, who said she was about to sing the chant, and that if the demon attacked her she would soon drive him out. The young woman fell in the usual fit, on which the countess, *prudens et cordata matrona*, with the aid of her daughter pulled up her dress and gave her a good whipping. 'She confessed to me afterwards that it completely cured her.' Extreme diseases, adds Weyer, require, according to Hippocrates, extreme remedies, but care should be taken to distinguish suitable cases.²

The last and most important section of the book treats of the punishment of witches, who are to be carefully distinguished from poisoners and magicians, such as Faust, who are often wealthy men and spend much money in travel, books, &c., to learn diabolic arts; or deceivers, such as the mason who buried wolves' dung in a cattle stall, and when the animals showed great excitement, said they were bewitched, and offered to cure them for a consideration. Such men, when proved to have done serious harm, are to be severely

¹ Op. cit., v. 34.

² v. 35.

punished. The less guilty should be admonished, and among them are those who spread superstitious practices and persuade sick people that they are bewitched by some old woman.

This is all that the laws of Church or State require, and is a very different thing from seizing poor women possessed by diabolic delusions, or on the malicious accusations or foolish suspicions of the ignorant vulgar, and casting them into horrible dungeons, whence they are dragged to be torn and crushed by every imaginable instrument of torture, till, however guiltless they are, they confess to sorcery, since it is better to give their souls to God in innocence, even through flame, than longer endure the hideous torments of bloodthirsty tyrants. And should they die under torture or in prison, the accusers and judges cry out triumphantly that they have committed suicide, or that the devil has broken their necks.

Here follows a burst of indignant eloquence which would have cost Weyer dear had he fallen into the clutches of the witch-hunters, and which may be given in the terse vigour of the original :

‘Sed ubi tandem is apparuerit quem nihil latet, Scrutator cordium et renum, ipsius abstrusissimae etiam veritatis Cognitor et Iudex, vestri actus palam fient, O vos prae fracti tyranni, O iudices sanguinarii, hominem exuti et caecitate ab omni misericordia procul remoti. Ad ipsius extremi iudicii tribunal iustissimum vos provoco, qui inter vos et me decernet ubi sepulta et calcata Veritas resurget vobisque in faciem resistet latrociniorum ultionem exactura.’¹

Their credulity almost equals their cruelty, as [shown] by the belief that a certain old woman caused the excessive cold of the preceding winter, and by the absurd swimming test. What effect can denial of faith, evil intentions, or a corrupt fantasy have upon a person’s specific gravity, on which floating depends? Moreover, women usually float, since their specific gravity is less than that of men, as Hippocrates pointed out.² But nothing is too absurd for a witch inquisitor. Some fishermen at Rotterdam drew up their nets full of stones but fishless. This was clearly witchcraft, so they seized an unfortunate woman who confessed in her terror that she had flown out of the window through a hole the size of a finger-end, dived under the sea in a mussel-shell,³ and there terrified the fishes

¹ vi. 4.

² vi. 9.

³ ‘Mossel-scolp nostratibus dicitur.’

and put stones in the nets. The woman, says Weyer, was evidently mad or deluded by the devil, but they burnt her all the same. Treachery and cruelty go together. A priest, having failed to make a witch confess, promised that if she would admit some small act of sorcery, he would see that she was released after some slight penance. Thereupon she confessed and was burnt alive.¹

In contrast to this, Weyer describes the method of dealing with witchcraft in the duchy of Cleves. In 1563 a farmer, finding his cows gave less milk than usual, consulted a witch-finder, who told him that one of his own daughters had bewitched them. The girl, deluded by the devil, admitted this and accused sixteen other women of being her accomplices. The magistrate wrote to the duke proposing to imprison them all, but the latter, probably at Weyer's instigation, replied that the witch-finder was to be imprisoned, the girl to be instructed by a priest and warned against the delusions of demons, and the sixteen women in no way to be molested.²

An old woman of eighty was arrested at Mons on charge of witchcraft, the chief evidence being that her mother had long ago been tortured to death on a similar charge. To make her confess they poured boiling oil over her legs, which produced blisters and ulcers, and her son hearing of it sent her a roll of lint to put round them. This was supposed to make magic bandages by the aid of which the woman might escape, and the son was promptly arrested. The mother was to be burnt in a few days, and her son would probably have followed, when Weyer, by permission of the Duke of Cleves, visited Count William of Mons and explained his views on witchcraft. He also examined the old woman, who was so broken down that she fainted several times, and finally obtained the release of both.³

Theologians (says Weyer in conclusion) may object that he is only a physician and bid him keep to his last. He can only reply that St. Luke was a physician, and that he is one of those who hope by the mercy of God and grace of Christ to attain that royal priesthood of which St. Paul and St. John speak. Finally he is ready to submit all he has said to the judgement of the Church, and to recant any errors of which he may be convicted.

The Church answered by putting his name on the *Index* as an *auctor primae classis*, that is, one whose opinions are so

¹ Op. cit., vi. 15.

² vi. 16.

³ vi. 16.

dangerous that none of his works may be read by the faithful without special permission, while his book was solemnly burnt by the Protestant University of Marburg.¹ The Duke of Alva, then engaged in his notorious work in the Netherlands, used his influence to get Weyer removed from his position at the court of Cleves. In this he was aided by the duke's increasing melancholia and ill health, which were considered by many a judgement upon him for his protection of Weyer and neglect of witch-burning. In 1578 Weyer resigned his post to his son Galen, and in 1581 witch-hunting commenced in the duchy of Cleves. Weyer, however, as befitted the chivalrous defender of outraged womanhood, enjoyed the friendship and protection of Countess Anna of Techlenburg, at whose residence he died, 1588, aged seventy-two.

The work on *The Deceptions of Demons* has been aptly compared to a torch thrown out into the darkness, which for a moment brightly illumines a small space and then disappears. It made a temporary sensation, and was welcomed by a few of the more enlightened spirits of the time; it saved the lives of some unfortunate women (being successfully quoted the very year after publication in defence of a young woman at Frankfort, who confessed she had flown through the air and had intercourse with the devil), and it marks the beginning of an open and persistent opposition to the witch mania. Spee also has a curious story showing the influence of Weyer's book :

' A great prince invited two priests to his table, both men of learning and piety. He asked one of them whether he thought it right to arrest and torture persons on the evidence of 10 or 12 witches. Might not the devil have deceived them in order to make rulers shed innocent blood, as certain learned men had lately argued, "thereby causing us pangs of conscience" ? The priest stoutly maintained that these pangs were needless, for God would never allow the devil to bring innocent men to a shameful and horrible death in this way; and so he (the prince) might continue the witch trials as usual. He persisted in this, till the prince said, " I am sorry, my father, you have condemned yourself and cannot complain were I to order your immediate arrest, for no less than 15 persons have sworn you were with them at the witch dances ", and he produced the records of their trials in proof. Then the good man stood like butter in the sun in the dog-days, and had nothing more to say for himself.' ²

¹ Diefenbach, p. 241.

² *Cautio Criminalis*, Dubium xlviiii.

But it had little effect on the superstition itself, which reached its height during the following half-century; and the author is compelled by his religious beliefs to admit so much that his position is hardly tenable. Indeed, his premisses had already been granted by the witch-hunters themselves. The jurist Molitor, for instance, admits that much witchcraft is imaginary and due to the 'deceptions of demons, but while the physician argues that these deceptions are rendered possible by disease, and are themselves largely of the nature of disease, so that the victims deserve pity and medical treatment rather than burning, the lawyer asserts that a person can only be so deceived by his free will, and therefore a woman who believes she has made a compact or had intercourse with the devil is as deserving of punishment as if she had actually done so.¹

Just over a century after the appearance of Weyer's book (1664)

'Sir Thomas Brown of Norwich, the famous physician of his time, was desired by my Lord Chief Baron [Hale] to give his judgement [in a case of witchcraft]. And he declared that he was clearly of opinion That the Fits were natural, but heightened by the devil co-operating with the malice of the witches at whose instance he did the villanies. And he added, That in Denmark there had been lately a great Discovery of Witches, who used the very same way of afflicting persons by conveying pins into them.'

The jury 'having Sir Thomas Brown's Declaration about Denmark for their encouragement, in half an hour brought them in guilty. . . . They were hanged maintaining their innocence.'²

Had Brown been better acquainted with *The Deceptions of Demons* he might have hesitated to make that 'Declaration about Denmark', but Weyer's early opponent, Bishop Binsfeld, has no difficulties. Quoting Origen (in Matt. xvii. 15) he exclaims, 'Physicians may say what they like, we who believe the Gospel hold that devils cause lunacy' and many other diseases.³ But for a demon to cause disease or do other harm, two things are requisite, the permission of God and the free will of some malicious person, witch, or sorcerer. The physician, Weyer, has denied the possibility of a compact with the devil, but is easily refuted by

¹ U. Molitor, *Tractatus de lamiis*, 1561, p. 27.

² Hutchinson, *Historical Essay concerning Witchcraft*, London, 1718, pp. 40, 118, 120.

³ Op. cit., Preludium, i.

Scripture and Church authority. Did not the devil try to make a compact with Christ Himself? ¹ Similarly he has no difficulty in showing that the Hebrew word for witch means much more than 'poisoner', and, given the almost universal beliefs of the age, it must be admitted that Brown and the bishop have the best of the argument.

In the opening chapter of his well-known work on rationalism, Lecky says that the decline of the belief in witchcraft 'presents a spectacle not of argument and conflict, but of silent evanescence and decay'; it was 'unargumentative and insensible'. Scot's work 'exercised no appreciable influence', and, so far as the result was concerned, he, Weyer, and their like might as well have kept quiet and waited for the change to be effected by 'what is called the spirit of the age', that is, 'a gradual insensible yet profound modification of the habits of thought' due to 'the progress of civilization'. This theory has been ably criticized elsewhere.² The truth it contains seems to be that argument would not have sufficed to change public opinion about witchcraft, without the aid of changes in other matters, and especially the development and success of scientific investigation. Such discoveries as the motion of the earth and circulation of the blood, when generally accepted (which was not till late in the seventeenth century), showed that the learned as well as the vulgar might be utterly mistaken in important beliefs supported by apparently good evidence, and that scientific methods of attaining truth differed widely from those of the witch-hunters.

The progress of civilization by practically abolishing the use of torture would alone have immensely diminished the number of victims, and of those 'confessions' on which the belief was fed. To use military language, the witch mania was an ugly and formidable redoubt connected with other forts and entrenchments. It suffered somewhat from the bombardment by Weyer and Scot, but could only be finally demolished by a general advance of the forces of science and civilization. But if every one had trusted to 'the spirit of the age' rather than disturb his neighbours' beliefs, we might still be burning our grandmothers.

Though born in what is now Holland and educated in France, German writers claim Weyer as their countryman and compare

¹ Preludium, vi.

² J. M. Robertson, *Letters on Reasoning*, London, 1905, cap. vi.

him with Martin Luther. The monk of Wittenberg is indeed a fine figure with his 'Here stand I; I cannot otherwise, God help me!' But he had half Germany behind him; both princes and populace were ready to protect him. Weyer stood practically alone, and if he escaped being burnt by jurists and theologians, had a fair chance of being lynched by an enraged mob as a sorcerer and protector of witches. There was little to save him from torture and death but the strength of mind of Duke William of Cleves, who came of an insane family and already showed signs of melancholia.

Weyer was happily spared such a trial of his fortitude, but none the less does he deserve our admiration as the chivalrous champion of womanhood, who first, with vizor up and lance in rest, greeted, alas! not, like the knights of legend, by prayers and blessings but by threats and imprecations, went forth to do open battle with the hideous monster which had so long tortured and slain the innocent and helpless.

وهذا كتاب الاسباب والعلامات
الحكيم موسي بن ميمون القزطبي الاسراي
العلامات ان كتاب النور ما رده فيه وكانت زكامه
كان في الالف او في احد مخبريه شده وفي الصوت غنة وبجد
العليل في الالف والخبه فقا وهدجا ورتا طهر من الماده ماله غلظ
ولروجه وان كتاب حاره وكانت زكاميه فحاره في الوجه والالف
ورقه السيلان ولذعه وحنه وحران ملسته وجمع في الوجه وكذلك
علامه ما ينزل في الصدر منها ان كان حاد الذاعا في الحلق ودغغه وحكه
وسفت العليل الرمو الحاد وان كان غلظ بارده فقل الصدر وطهور
المعت الغلظ ورتا كان معها صيون نفس العلاج الفصد عند
اسدائها والاسهال ان دعت الحاجه وملطف الفدا والادصار منه على
جسم وما حاله ودهن اللوز والسكر الطبرزدوسر والستعرا وكل المنزوه
ما لا تشر او العرش مع حلب اللوز كذلك مله امام الالف نظهر النصح
وينزل من الالف ما شخ من الماده يدخل حنك الحام وينظر الى العاصم على
مقدم الراس وسفك النار الى المطوح فده السفسج والسوفور والباونج
واكليل الملك ولا ينبغي ان ينظر الحام الا بعد النصح الا ان يكون ساك حامي
فلا ينبغي ان يهرب الحام فان كتاب التزلحاره روفه يلبس الحلك على حرقم
ويستوق خاره او يلقى على الجمر خاله فدققت في الكلر وسبستوق خاره

THE 'TRACTATUS DE CAUSIS ET INDICIIS
MORBORUM'

كتاب الاسباب والعلامات

ATTRIBUTED TO MAIMONIDES

BY REUBEN LEVY

AMONG modern authorities on Arabian medicine, the opinion has been widely held that the position of Maimonides as a medical writer must depend mainly upon an unpublished work from his hand, known as the *Tractatus de Causis et Indiciis Morborum*.¹ It is here sought to demonstrate that the Bodleian MS. (Marsh 379), hitherto regarded as containing this work, is in reality by another author, while the Paris MS. (Bibliothèque Nationale, Ancien Fonds 411),² the only other alleged copy of the *Tractatus de Causis et Indiciis Morborum*, contains in fact no such work. Moreover, evidence will be adduced showing that it is not probable that Maimonides composed a treatise of this scope.

For their information concerning the *Tractatus*, the modern bibliographers evidently rely entirely on entries in the catalogues of the respective libraries. The 1739 Catalogue of Arabic and Hebrew MSS. in the Bibliothèque Nationale contains the following entry:³ 'Codex bombycinus, Aleppo in bibliothecam Colbertinam anno 1673 illatus, quo continetur R. Mosis Maemonidae de morborum causis et illorum curatione tractatus, Arabice, caractere Hebraico.' Careful examination of the manuscript disclosed the fact that it contained no fewer than four works of

¹ See (a) H. Haeser, *Geschichte der Medizin*, Jena, 1875-82, vol. i, p. 596; (b) A. Hirsch, *Biographisches Lexicon der hervorragenden Aerzte*, Leipzig, 1884, art. 'Maimonides', vol. i, p. 178 f.; (c) K. Brockelmann, *Geschichte der arabischen Literatur*, Weimar, 1897-1902, vol. i, p. 490.

² = No. 1211 in Zotenberg's Catalogue, Paris, 1866.

³ Vol. i, p. 40, Cod. 411.

Maimonides, viz. on Poisons,¹ on Asthma,² the *Tractatus de Regimine Sanitatis*,³ and the *Tractatus de Morbo Regis Aegypti*,⁴ all bound together in confusion.⁵ All these are known to be by Maimonides, and there is nothing besides them in the volume.

There has always been a good deal of confusion about the works *de Regimine Sanitatis* and *de Morbo Regis Aegypti*. The former is variously known as *de Regimine Sanitatis*, *de Cibo et Alimento*, *de Dietetica*, 'the letter to the Sultan', or as 'the Consultation concerning (the Sultan) Al Afdal'.⁶ The latter also has a number of titles, such as *de Causis Accidentium*,⁷ *de Morborum Causis et Curatione*, and *Responsum ad Regem Raqqa*, in addition to its title of *de Morbo Regis Aegypti*. In 1514, in Venice the two treatises were printed together in Latin as one work.⁸

Leclerc⁹ has made confusion worse confounded by saying that 'ce que l'on a désigné sous les titres, *De Morbo Regis Aegypti*, *De Causis Accidentium*, *De Causis et Indiciis Morborum*, *De Cibo et Alimento*, ne sont autre chose que tout ou partie du même ouvrage'.¹⁰ No doubt he was led into making this statement

¹ في السموم. Translated into Latin by Armengaud de Blaise of Montpellier; into French by J. M. Rabbinowicz, *Traité des Poisons de Maimonide*, Paris, 1865, and into German by M. Steinschneider, *Gifte und ihre Heilung, eine Abhandlung des Moses Maimonides*. Virchow's *Archiv*, LVII, vol. i, pp. 92-109.

² في الربو. Unprinted. We hope shortly to issue this work.

³ رسالة الافضلية في تدبير الصحة. 'Letter to [the Sultan] al Afdal.' Printed in Latin at Florence, n. d.; Venice, 1514, 1521, &c.; Leyden, 1535; in the Hebrew translation of Moses ibn Tibbon edited by Jacob Saphir ben Levi, Jerusalem, 1885; and in German by Winternitz, *Diätetisches Sendschreiben des Maimonides*, &c., Vienna, 1843.

⁴ Printed in the Latin edition [Venice, 1514] of the *de Regimine Sanitatis* as Tractatus V of that work.

⁵ See L. Leclerc, *Histoire de la médecine arabe*, Paris, 1876, vol. ii, p. 60, and M. Steinschneider, *Die hebräischen Uebersetzungen des Mittelalters und die Juden als Dolmetscher*, Berlin, 1893, pp. 767, 772, 773.

⁶ رسالة الافضلية. ⁷ في بيان الاعراض = on the diagnosis of accidents. ⁸ في اسباب الاعراض

⁸ See note 4.

⁹ Op. cit., vol. ii, p. 61.

¹⁰ See Steinschneider, *Hebräische Uebersetzungen*, p. 770, and his *Catalogus Librorum Hebraeorum in Bibl. Bodl.*, Berlin (1852-60), p. 1921. In the *Zeitschrift der Morgenländischen Gesellsch.*, vol. xxx, p. 145, he makes the bare statement that the *Tractatus de Causis et Indiciis Morborum*—the *Hauptwerk* of Maimonides, as it is called by Haeser—rests upon an error. In his catalogue of Bodleian books (p. 1926) he puts the book down as a bookseller's fraud after what is obviously only a cursory glance. He says 'fraude bibliopolae ex variis opp. imperfectis confictus est, in quibus an Nostri sit aliquid non facile eruendum est'.

partly by the fact that Wüstenfeld¹ gives the title of *de Causis et Indiciis Morborum* both to the Bibliothèque Nationale MS. (which Leclerc knew as *de Causis Accidentium*) and to the Bodley MS.

The entry concerning the latter in Uri's Bodleian Catalogue of 1787² reads as follows :

'Codex bombycinus, anno Hegirae 765, Christi 1363 exaratus, folia 116 implens. Comprehendit succinctum de omnium corporis humani morborum causis, signis et remediis tractatum ab Ibn Hobaish Hierosolymitano ex Hebraica lingua in Arabicam conversum, cui sectiones sex supra centum sunt. Initium fit a morbis capitis; finis in elephantiasi. Composuit Musa Ben Maimun Alcortubi, Israelita. [Marsh 379.]'

The MS. bears upon one of its pages the title

هذا كتاب الاسباب والعلامات الحكيم
موسى بن ميمون القرطبي الاسراييلي

'This is the book of the causes and symptoms, by the Doctor Mûsa ibn Maimûn the Cordovan, the Israelite.' (Plate XL.)

As a matter of fact it is no such thing. This title, together with an extra title-page and colophon in the same hand, is a much later addition to the MS., which also has a fragment of some other medical work—at present unidentified—bound up with it. The folios of the MS. which deal with the *Tractatus* have been bound together in extreme disorder, but examination of them has shown that they really form a fragment of the second book of *المختار في الطب*, the *Delectus de Medicina*, by *مهدب الدين ابو* Muhaddib ed Din Abu'l Hasan Ali Ibn Ahmad of Bagdad.³

Ibn Abi 'Uṣaibia (1203–1269)⁴ gives a life of this writer and a list of his works, which includes the *Delectus de Medicina*. Accord-

¹ H. F. Wüstenfeld, *Geschichte d. arabischen Aerzte*, Göttingen, 1840, § 198, No. 7.

² *Bibliothecae Bodleianae codicum manuscriptorum Orientalium . . . catalogus a Joanne Uri confectus*, Oxford, 1787, vol. i, p. 140, No. 594.

³ Also known as *الاخلاطي* (of Akhlat) or *التبريزي* (of Tibriz) and as *ابن هبل* (Ibn Hubal).

⁴ Ibn Abi 'Uṣaibia wrote an invaluable dictionary of the lives of the most noted physicians, entitled *كتاب عيون الازباء في طبقات الاطباء* (= The book of the sources of information concerning the various classes of physicians). It is especially full on the lives of Arab physicians. See the edition of A. Müller, Königsberg, 1884, vol. i, pp. 304–6.

ing to him, Muhaddib ed Din was born at Bagdad in A. H. 515 (= A. D. 1121), and after studying medicine and philosophy settled at Mosul. Later he became the physician of the Shah Arman, chieftain of Khalāt on Lake Van in Armenia, in whose service he amassed great wealth. He completed the *Delectus* at Mosul in the year A. H. 560 (= A. D. 1164), and died there in A. H. 610 (= A. D. 1213), with the reputation of being first physician of his time.

Another fragment of the same work of Muhaddib ed Din, which includes most of the contents of the Bodleian MS., besides a good deal of material which has been lost from the latter, exists in the British Museum.¹ The Leyden Library contains a unique copy of the work in three books. This is claimed to be complete by the Catalogue of the library,² although Bar Hebraeus [1226–1286]—Catholicus of the Jacobite (Monophysite) Church³—says that the work ran into four parts.⁴ The three books of the Leyden MS. treat (i) of generalities (i. e. Anatomy, Physiology, and the general causes of disease), (ii) of medicaments, and (iii) of particular diseases and their treatment.

The Bodleian and British Museum MSS. contain part of the third book, which was probably in general use by itself as a dictionary of medicine. The British Museum copy has only lost the earlier chapters of this third part, but the Bodleian MS., although possessing a few more chapters at the beginning, is far less complete in the other portions.⁵

Wüstenfeld and the bibliographers that followed him have

¹ C. Rieu, *Supplement to the Arabic MSS. in the Brit. Mus.*, London, 1894, No. 796, II.

² Vol. iii, p. 242 of the Catalogue of Arabic MSS. compiled by P. de Jong and M. J. de Goeje, Leyden, 1865–6.

³ Abu'l Faraj Gregory, Bar Hebraeus (Wüstenfeld, op. cit., No. 240).

⁴ In his work entitled *تاريخ مختصر في الدول*, 'Compendious History of the Dynasties' (edited and translated by E. Pocock, Oxford, 1663), p. 457 f. of the Arabic and p. 300 of the Latin. Beyrout edition, 1890, p. 420.

⁵ Two MSS. of the work are mentioned in the Catalogue of the Khedive's library, *فهرست کتابخانه خدیویة*, vol. vi, p. 38. For further references concerning Muhaddib ed Din and his works, see (a) Wüstenfeld, op. cit., § 202; (b) Brockelmann, op. cit., vol. i, p. 490; (c) P. de Koning, *Traité sur le calcul*, Leyden, pp. 186–228. The more important Arab authors other than Ibn Abi 'Uṣaibia are: (d) Bar Hebraeus, Pocock's edition, p. 457 of the Arabic part and p. 300 of the Latin part, Beyrout edition, p. 420; (e) Haji Khalfa, G. Fluegel's edition, Leipzig and London, 1835–58, vol. v, p. 436, No. 11584.

evidently derived their information concerning these MSS. from the catalogues of the Bodleian Library and of the Bibliothèque Nationale. No mediaeval bibliographer has up to the present been found who mentions this book of Maimonides.¹ Wüstenfeld's usual authority for his statements is the great thirteenth-century medical biographer, Ibn Abi 'Uṣaibia. But, though the latter gives a life of the Hebrew physician and a list of his writings,² he makes no mention of the *Tractatus de Causis et Indiciis Morborum*. Moreover, this *Tractatus* has no place in Haji Khalfa's admirable bibliography of Arabic works, which contains notices of four books bearing the title *De Causis et Indiciis Morborum*, not one of which is by Maimonides. Lastly, neither the historian Al Qifti in his *Classes philosophorum et astronomorum et medicorum*,³ nor Bar Hebraeus, who is said to have plagiarized him,⁴ notice the work in their sketches of the physician's life.

The Bodleian MS. alleged to contain the *Tractatus* is one of a collection of over seven hundred volumes bequeathed to the library on his death, November 2, 1713, by Narcissus Marsh, Archbishop successively of Cashel, Dublin, and Armagh. Most of his Oriental MSS. had been procured for him either in the East by Robert Huntington, Bishop of Raphoe and chaplain to the English merchants at Aleppo, or at the sale of Golius's library at Leyden in October 1696.⁵ Golius was a Dutch orientalist, born at Leyden in 1596. He studied medicine and Oriental languages at the University of Leyden, and after leaving it he accompanied a French embassy to Morocco in 1622. He remained in Morocco for two years, and while there collected various MSS. On his return in 1624 he was appointed to the Chair of Arabic at Leyden, but was allowed a period of leave for travel in the East before taking up his appointment. He took with him a grant of money for the purchase of MSS., and these to the number of over two hundred are now deposited in the University

¹ See J. Pagel, 'Maimuni als medizinischer Schriftsteller', in the volume of studies on 'Moses ben Maimon' edited by W. Bacher and others, Leipzig, 1908, vol. i, p. 232.

² Op. cit., vol. ii, p. 117.

³ طبقات الحكماء واصحاب النجوم والاطباء in MS. at British Museum (see Catalogue of Oriental MSS. at the British Museum, London, 1846, part II, No. 1503, p. 684), Leyden, Berlin, Escorial, and elsewhere. See Brockelmann, op. cit., vol. i, p. 325.

⁴ See Leclerc, op. cit., vol. i, p. 5.

⁵ See W. D. Macray, *Annals of the Bodleian*, Oxford, 1890, p. 270.

Library at Leyden. On several occasions during his travels in Arabia attempts were made by Arab chiefs to detain him for his medical knowledge, but he returned safely and later wrote a number of works mainly concerned with Arabic. He died in 1667.

Among the MSS. which Golius himself procured for the Leyden Library was that of the *Delectus*. It is at least unlikely therefore that such a profound Arabist, who was also a medical man, would have bought the Bodley fragment for a genuine work of Maimonides; the primary responsibility for the error thus probably rests with Huntington. However that may be, it was Uri, in his catalogue of the Bodleian MSS., who first published the error, and from him it was passed on to the modern bibliographers.

John Uri was a Hungarian who had studied Oriental literature under Schultens at Leyden, and was recommended to Archbishop Secker for the purpose of cataloguing the Bodleian Oriental MSS., by Sir Joseph Yorke, then ambassador in the Netherlands.¹ Many years were occupied in the preparation of the work, which appears to have commenced in 1766 and was not completed till 1787. In spite of the length of time which Uri occupied in his task, his successor, Pusey, found sufficient errors in it to fill sixty closely printed pages. In his preface to the second volume of the Catalogue, issued in 1835,² Pusey complains 'Urius vero MSS. haud raro negligenter exscripsit', and says that on re-examination of Uri's work he discovered, 'besides the errors which Uri himself would have admitted, that nearly all the purchasers of these books, Pocock alone excepted, had had spurious works foisted on them by wily Orientals. He therefore looked through all the books which Uri had enumerated, excepting the more common ones, to see if they corresponded to their titles or not. By doing this he discovered various irregularities. In some cases the titles had been covered over with paper or obliterated with ink, or practically erased with a knife. In others, by slight changes in the authors' names, more famous people were indicated as responsible for the works. Lastly, by changing the pagination in some of the volumes fragments were represented as complete

¹ See Macray's *Annals of the Bodleian*, p. 271, and the *Dict. of National Biography*.

² *Bibliothecae Bodleianae codicum manuscriptorum . . . catalogus*, vol. ii, ed. A. Nicoll and E. B. Pusey, Oxford, 1835, p. iv.

works, and a few pages of one work were even occasionally sewn on at the beginning of another.'¹

Uri's errors will be the more readily condoned when it is remembered that he did not specialize on the Arabic MSS. alone, and that his work seeks to catalogue, *for the first time*, a two hundred years' accumulation of Oriental MSS., including Hebrew, Aramaic, Syriac, Aethiopic, Arabic, Persian, Turkish, and Coptic writings. Nevertheless, Uri's entry with reference to the present MS. deserves some of Pusey's criticism. The MS. has three parts, each written in a different hand, the first and most important part being the supposed *Tractatus de Causis et Indiciis Morborum*, which covers folios 2-87. The second part is a fragment of some as yet unidentified medical work (folios 88-115); and the third, consisting of the first and last folios, gives us an introduction and an end piece to the first part.

The alleged author and translator are named on the first page:

هذا كتاب موسى ابن ميمون الفه
 للعموم قاطبا وقد نقله التميمي
 الشيخ سليمان الحبشى المكنى بابن حبيش
 في مملكة القدس الشريفة
 تم

'This is the book of Mûsa ibn Maimûn which he put together as a compilation for general use. Al Tamimi, the sheikh Sulaiman the Abyssinian, known as Ibn Hûbaish,² translated it in the noble city of Jerusalem. Finis.'

¹ 'Praeter errores enim quos ipse admiserit Urius, deprehendi omnibus fere horum librorum emptoribus, uno Pocockio excepto, libros supposititios pro veris subinde venditasse vafros Orientales. Codices ergo fere universos Arabicos, quos recensuit Urius (vulgatioribus quibusdam exceptis) oculis perlustravi, quo certius scirem titulisne responderent an non. Quo facto varias errorum formas deprehendi, titulis nunc charta coopertis, nunc atramento oblitis, nunc cultro paene abrasis; auctorum porro nominibus paullulum immutatis quo notiora quaedam referrent, numeris etiam quibus singula volumina signata sunt permutatis, quo quis opus imperfectum pro integro habeat, paginis denique pauculis operi alieno a fronte assutis.'

² Steinschneider (*Cat. Libr. Hebr. in Bibl. Bodl.*, p. 1926) says this title is invented and no doubt suggested by the name of Al Tamimi al Muqaddasi (the Jerusalemite), a doctor of the tenth century (Wüstenfeld, § 112) often praised by Maimonides in the Aphorisms, e. g. at the end of chap. 20. Pusey's only note on Uri's entry in the MS. is concerned with this title (vol. ii, p. 588): 'Translator in Cod. appellatur Alsheikh Soleiman Alhabashi, notus in terra Hierosolymitana nomine Ibn Hubaish. Opus autem A. D. 1363 ex Hebraico transtulit.'

On the next page there is an introduction to the book which commences :

بسم الله الرحمان الرحيم
قال موسى ابن ميمون القرطبي الاسرايلى الخ

'In the name of God, the Merciful, the Compassionate.

'So says Mûsa ibn Maimûn, the Cordovan, the Israelite,' &c.

The whole of the passage is an extract from chapter vi of the Aphorisms of Maimonides, adapted as a kind of introduction, and runs as follows :

قد علمت في قولي هذا في قوة النفسية والقوة الحيوانية والقوة الطبيعية ولنسم الان في هذا الاصطلاح جميع افعال البدنية للانسان قول ان اشرف الافعال التنفس وبعده النبط والاحساس واشرف الاحواس البصر ثم السمع وبعده الاحساس شهوة الطعام والشراب وبعده ذلك الكلام وبعده ذلك التمييز اعني الذي بها النقل والفكر وبعده ذلك الكلفة لسائر الاعضاء علي المعنائة وهذه الرتبة في شرف انما هي بحسب ضرورة الكيفية او صالحية فتعلم ان الطبيعة اسم مشترك يقال علي معنى كثيرة كالقوة المدبرة الحيوان ايضا طبيعية وما هو اشرف وتمسكت للاشرف في الاشراف وهذه الاسباب الذي قد رايناها ورتبناها وهو الابتداء في النزلات الزكامية من الراس *

Trans. 'I teach in this discourse of mine concerning the animal power, the vital power, and the natural power, but we will here call all man's bodily functions by one name. There is a saying that the noblest of the functions is breathing, next the pulse, and lastly the senses. Of the senses, the noblest is sight, which is followed by hearing. Following on the senses is the appetite for food and drink, after it being speech and then the mind; I mean that which contains the reason and the intellect. Next comes the [?] allocation of [the various powers to] the other parts of the body according to the customary manner. This arrangement in order of nobility is only according to the requirements of life or [?] health.

'You will recognize that "nature" is an equivocal term which can be used in many meanings. [One of these meanings,] for example, is "the motive power of animals". So, too, is "natural".

[? . . .] 'and that which is nobler. And you will retain the noblest of the noble [functions]. And these causes which we have

noticed we have set down in their order; and the beginning is concerning catarrhal discharges from the head.'

Compare with this the real text of Maimonides :¹

קד עלמת קול אלאטבא קוי' נפסאניה וקוי' חיואניה וקוי' טביעיה.
 ולנפס אנא אלן פי הרה אלאצטלאח גמיע אפעאל ברן אלאנסאן אלאפעאל
 אלברניה [ואשרף אלאפעאל אלתנפש ובעדה אלנבט²] ובעדה אל אחסאם.
 ואשרף אלחואם אלבצרי. תם אלסמע ובעד אלאחסאם שהוה אלטעאם
 ואלשראבי. ובעד דאלך אלכלאם. ובעד דאלך אלתמייו. אעני בה אלתכיייל
 ואלפכר ובעד דאלך חרכה סאיר אלאעצא עלי מעתאדהא והרה אלרמבה³
 פי אלשרף אנמא הי בחסב צרוריה אלחיאה או צלאחיה אסתמראהא"
 ובעד הרה אלמקדמה פלתעלם אן אלטביעה אסם משתרך יקאל עלי
 מעאני כתירת ומן גמלה תלך אלמעאני אלקוה אלמדברה לברן אלחיואן
 פאנהא אלאטבא יסמונהא איצי טביעה והרה אלקוה הי איצי
 פאן גלבת ען דלך ברלת מא הוא אשרף ותמסכת באלשרף פאלאשרף
 ובחסב הרה אלתרתיב יעלם אלמרין אלה'.

'Thou knowest the opinion of the physicians [concerning] animal power, vital power, and natural power. But it is my intention here to call all the functions of man's body by the one name of "bodily functions". [The noblest of the functions is breathing, next the pulse,²] and lastly the senses. Of the senses, the noblest is sight, which is followed by hearing. Following on the senses is the appetite for food and drink, after it being speech and then the mind, by which I mean the thoughts and the intellect. Next comes the motion of the other parts of the body according to their customary manner. This arrangement in order of nobility is only according to the requirements of life or the health of its faculties.

'From this preface you will recognize that "nature" is an equivocal term which can be used in many meanings. One of these meanings [for example] is "the motive power in the bodies of animals" which the physicians call "nature" too. . . . And if you discover this, you will exchange that which is nobler and retain that which is noblest. By means of this process of arrangement, a disease can be recognized,' &c.

¹ From the text of the Aphorisms as given in the Bodleian MS. Pocock 319.

² Omitted from the MS. obviously by accident.

³ No doubt for רתבה.

This introduction was added when the folios stood in a state of disorder different from their present one. The catchword at the bottom of the page [وهذا = and this] points forward to the title already mentioned,¹ which appears on folio thirty-nine of the present arrangement. The text below this title is part of the chapter on discharges and catarrh, so that the folio once followed immediately on the introduction, being then, too, out of its proper place.

The last page, written in the same hand as the introduction, bears a piece of some unidentified work and a colophon which reads:

وقد تم هذا الكتاب الشريف تاليف موسى ابن ميمون القرطبي
الاسرائيلي رحمه الله مما ألف وجرب هذا الكتاب المبارك، وعدن فصوله
مائة وست فصول للجَميع (sic) امراض البدن مما رتبته على اوضاعه
تم الكتاب فى سنة ٦٥٢٧ (sic) سبع مائة وخمسة وستين *

'This noble book is finished; the composition of Mûsa ibn Maimûn the Cordovan, the Israelite, to whom God be gracious. This blessed book is part of that which he composed and tested. The number of its chapters is 106, dealing with all the diseases of the body, which he arranged in their proper order.

'The book was completed in the year 765.'²

The number 106, which according to the colophon is the number of chapters in the book, is really the number of titles in the MS. written in large hand. Fragments of many chapters whose titles are lost still remain in it however, while many of the chapters that have preserved their titles are no longer complete.

Again it may be pointed out that all the known medical works of Maimonides were written in Arabic and therefore did not need to be translated into that language as the Bodleian MS. claims to have been. The spurious title-page thus further betrays itself by saying that this work was translated from *Hebrew*.

Finally, the identification of the real contents of the Paris MS. disposes of the last foundation of the idea that Maimonides wrote any compendium of medicine known as *كتاب الاسباب والعلامات* (*Tractatus de Causis et Indiciis Morborum*), and clears up the confusion caused by the faulty entries in the Paris and Bodleian catalogues.

¹ See p. 227.

² = A. D. 1363. The numerals which accompany the written figures are equivalent to 6,527 and are meaningless.

SCIENTIFIC DISCOVERY AND LOGICAL PROOF

By F. C. S. SCHILLER

§ 1. AMONG the obstacles to scientific progress a high place must certainly be assigned to the analysis of scientific procedure which Logic has provided. This analysis has not only been inadequate in itself, but has set itself a mistaken aim. It has not tried to describe the methods by which the sciences have actually advanced, and to extract from their experience the logical rules which might be used to regulate scientific progress, but has treated scientific discoveries almost entirely as illustrations of a preconceived ideal of proof, and so has freely rearranged the actual procedure in accordance with its prejudices. For the order of discovery there has been substituted an order of 'proof', and this substitution has been justified by the assumption that if discovery had taken the ideally best course, it would have coincided with the process of proof. It followed, of course, that the same logic would do for both, and that this logic was already in existence.

The damage thus inflicted upon Science was twofold. Not only were the logicians given a plausible excuse for persisting in their profound misapprehension of scientific inquiry and rendered incapable of giving any help or guidance in the solution of actual problems, but, what was much worse, the scientists themselves were misled about the nature of their operations.

The precise value of the service which a correct logical analysis of its procedure might have rendered to Science is perhaps open to dispute, though it must surely be beneficial to operate consciously, and with a full understanding of their nature, the methods which have been hit upon empirically ; but even if logicians have commonly been too unfamiliar with the details of scientific problems to offer much practical advice, it would be difficult to overrate the mischiefs which must have resulted from referring scientists to an incorrect analysis of their actual procedures. For the attempt to justify by such a false ideal what they had actually done was bound to divert their attention from the methods that were actually effective and fruitful to others which were impracticable

and sterile, to waste energy upon false aims and impossible ideals, and so to hamper scientists fatally in the exercise of their scientific rights and powers.

Hence it is not too much to say that the more deference men of science have paid to Logic, the worse it has been for the scientific value of their reasoning, while the less they have troubled to know about the theory of Science, the better it has been for their practice.

Fortunately for the world, however, the great men of science have usually been kept in salutary ignorance of the logical tradition and left to their own devices, by the accident that the historical organization of academic studies nearly everywhere confined 'logic' to the literary curriculum. Nevertheless, the moral of this situation is not that it is right for science to neglect logic and for logic to despise science, but that science should appeal from logic as it is to logic as it ought to be, and should insist on being provided with a *reformed* logic. For surely if a scientific education is to be more than a narrow and technical specialty, and is to exert a 'liberalizing' and broadening effect on the mind, it *ought* to include a study of scientific method in its generality and a certain understanding of the intellectual instruments by which all others are operated and constructed.

The whole evidence for these contentions it will not, of course, be possible to marshal within the limits of this essay, but the systematic criticism to which the whole traditional logic has been subjected in my *Formal Logic*¹ may perhaps absolve me from the duty of substantiating them exhaustively. It may suffice to indicate the extent of the scientific grievance against 'logic' by drawing up a list of problems in the logic of science which the traditional logic has misconceived, and then to select for fuller treatment a palmary example of the radical discrepancy between the two.

The traditional logic may be convicted of having gravely misrepresented, (1) the value of classification and the formation of classes, scientific processes of which the real logic was only revealed by the Darwinian theory, (2) the function of definition, (3) the importance of analogy, (4) of hypothesis and (5) of fictions, (6) the incomplete dependence of scientific results on the 'principles' by which they are (apparently) obtained, (7) the formation of scientific 'law' and its relation to its 'cases', (8) the nature of causal

¹ Published by Macmillans, 1912.

analysis. Other important features of scientific procedure cannot be said to have been recognized at all, e. g. (9) the problem of determining what is *relevant* to an inquiry and what practically must be, and safely may be, excluded, (10) the methods and justification of *selection*, (11) the essentially *experimental* nature of all thought and consequent inevitableness of *risk*, (12) the necessity of so conceiving 'truth' and 'error' that it is possible to *discriminate* between them, and (13) the need for an inquiry into *meaning* and into the conditions of its communication.

I

§ 2. The most instructive, however, of the discrepancies between 'logic' and scientific procedure will appear if we compare the logical notion of *proof* with the scientific process of *discovery*, and examine how far it can afford any means of regulating, stimulating, or even apprehending the latter. We shall find that the logical theory of 'proof' has no bearing on the scientific process of discovery, is not related to what the sciences call proof, and can only have a paralysing influence on any scientific activities which try to model themselves upon it. On the other hand, the study of the process of discovery will point to an important correction in the notion of logic.

§ 3. The scientific uselessness of the traditional logic should not, however, excite surprise. For what reason was there to expect that the theory of proof should turn out to be adequate, or even relevant, to scientific procedure? It had sprung from a totally different interest, proceeded on different assumptions, and aimed at different ends. It did not spring from interest in the exploration of nature, and did not aim at its prediction and control. Nor did it presuppose an incomplete system of knowledge which it was desired to extend and improve. It originated in a very special context, from the social need of regulating the practice of dialectical debate in the Greek schools, assemblies, and law-courts. It was necessary to draw up rules for determining which side had won, and which of the points that had been scored were good.

These were the aims Greek logic set itself, and successfully achieved. But the impress of this origin remains stamped all over it, and the accounts given of logical proof ever since have retained essential features of Greek dialectics.

Thus it was assumed that science could start from principles, as indisputable as are the current meanings of words in a dialectical debate, and the end of the whole theory of proof was always conceived as being to secure the conviction (*ἔλεγχος*) of one party to a dispute, who was to be definitely crushed by the triumphant cogency of a syllogistic demonstration, while the more real and fruitful analogy between scientific inquiry and debate, viz. that *there is always another side*, to which also it is well to listen, was unfortunately obscured by Aristotle's discovery of the syllogistic form and its show of conclusiveness. But for the purpose of apprehending scientific procedure the syllogism is a snare: by putting scientific reasoning into syllogisms, the difference between the true and the false views is made to appear qualitative and absolute, instead of being a quantitative question of more or less of scientific value. Thus dogmatism is fostered at the expense of progressiveness, and the mistake is committed of approaching the discovery of truth in a party spirit. Hence its dialectical origin has become *fons et origo malorum* for logic.

§ 4. It is true that this mistake is very old, and has grown deeply into the fabric of logic. For Aristotle had no sooner worked out the classic formulation of the rules of dialectical proof than he proceeded to extend their scope by applying them to the theory of science, in the *Posterior Analytics*. His instinct in so doing was sound enough; for there is no better verification of a theory than its capacity to bear extension to analogous cases. And of course if this extension had been successful, it would have supported the belief that the theory of discovery could profitably be amalgamated with that of proof.

Unfortunately, however, the verification only seemed to be successful. Aristotle chose to exemplify his theory of scientific proof from the mathematical sciences. His choice was natural enough, because they were the only sciences which had reached any considerable development in his day, and they had, moreover, an apparent necessity and universality and a fascinating appearance of exactness. But he had unwittingly chosen the most difficult and deceptive exemplification of scientific procedure. Because the mathematical sciences were in a relatively advanced condition they seemed to lend themselves to his design. He could there find terms whose meaning, and principles whose truth, was no longer in dispute. They could in consequence be argued from

with as much assurance as debaters could assume the recognized meanings of words. And the fact that results seemed to follow from mathematical definitions and premisses which were not merely verbal, shed a delusive glory on the forms of dialectical proof by which they had been reached. Hence it easily escaped notice that the logical superiority of mathematics was an achievement, not a datum. Just because the mathematical sciences were very ancient, their origins had been forgotten, and with them the tentative gropings which had first selected, and subsequently confirmed, their principles. They had become immediately certain and 'self-evident', and no one was disposed to dispute them. On this psychological fact the whole theory of logical proof was erected.

Again, it was natural to suppose that the true nature of scientific knowing must be revealed in its most perfect specimens: no one stopped to reflect that even so the real difficulties of making a science are more keenly felt and more easily seen in the nascent stage than in one which has victoriously overcome them, and has rewritten its history in the assurance of its prosperous issue.

Lastly, the subtle ambiguity which pervades all mathematical reasoning, according as its terms are taken as *pure* or as applied, was overlooked entirely—with the disastrous result that the universality, certainty, and exactness pertaining (hypothetically) to the ideal creations of 'pure' mathematics were erroneously transferred to their 'applied' counterparts. To this day logicians are found to argue that real space is homogeneous because it is convenient in Euclidean geometry to abstract from the multitudinous deformations to which bodies moving through it are subjected, and to leave them to be treated by physics;¹ nor are they aware of any lack of 'exactness' and discrimination when they identify the ideal triangle with the figures they draw on the blackboard.

§ 5. After its apparent success in analysing mathematical procedure there was no more disputing the supremacy of the theory of 'proof'. The facts that its field of application was soon found to be much narrower than that of science, and that it failed egregiously to apply to the procedures of the (openly) empirical sciences, and *a fortiori* could not justify them, if they were noticed at all, were held merely to show that these sciences stood on a low level of

¹ Cf. Mr. H. W. B. Joseph's *Logic* ², p. 548.

thought, which from the loftier standpoint of logic could be contemplated only with contempt; if they required help and got none, so much the worse for them. Accordingly the whole theory of science was so interpreted, and the whole of logic was so constructed, as to lead up to the ideal of demonstrative science, which in its turn rested on a false analogy which assimilated it to the dialectics of 'proof'. Does not this mistake go far to account for the neglect of experience and the unprogressiveness of science for nearly 2,000 years after Aristotle?

§ 6. Yet the deplorable consequences of this error should not render us unjust. The influence of Aristotelian logic on the theory of science was natural, and in a sense deserved. For Aristotelian logic is perhaps the mightiest discovery any man has achieved single-handed. Its might is sufficiently attested by the length of its reign. Euclidean geometry alone is comparable with it, and Euclid owed far more to his predecessors than Aristotle. Moreover, the Aristotelian logic may be said to have achieved its purpose. It was able to regulate dialectical discussion. The syllogism did determine whether a disputant had proved his case, and for any one who had accepted its assumptions its decision was final, while even its severest critics had to admit that it was an indisputable fact, the interpretation of which was a real problem.

Unfortunately, there is not yet any agreement among logicians about the solution of this problem. Aristotle's own analysis did not go back far enough: he stopped short at the *Dictum de Omni* and the reduction of syllogisms in the second and third figures to the first. He did not penetrate to the ultimate assumptions which were implied in the dialectical purpose and social function of the syllogism. But the truth is that syllogistic reasoning presupposes quite a number of conventions which Aristotle did not state, and which can hardly be said to have been adequately recognized since.

§ 7. (1) The first of these may be called the Fixity of Terms. Syllogistic reasoning manifestly depends on the assumption that the terms occurring in it have meanings sufficiently stable to stand transplantation from one context to another; for only so can they establish connexions between one context and another. Thus a syllogism in *Barbara* argues that because *all M is P* and *all S is M*, *all S must be P*. But it can do this 'validly' only if *M*, its

middle term, remains immutably itself, and is the same in both premisses. Doubt, dispute, or confute this assumption, and the cogency of the syllogism as a form of 'proof' is overthrown at once. If the sense in which *M is P* is not the same as that in which *S is M*, the syllogism breaks in two, and its conclusion becomes precarious. Raise the question of how far reality conforms to this assumption, and you get at once a subtle problem of the applicability of the syllogistic form to the case in hand, which is precisely analogous to the question whether a theorem of pure mathematics is applicable to the behaviour of a real thing. In either case the cogency of the 'proof' which establishes the conclusion is impaired and ceases to be unconditional. The conclusion of a 'valid' syllogism will only follow *if* the middle term can be known to be unambiguous, and if the objects designated by the terms do not change rapidly enough to defeat the inference. And that this is the case can usually be ascertained only by actual experience. The conclusion, therefore, cannot be simply deduced; it has actually to *come true*, before we can be sure that the reasoning *was* sound. Absolutely *a priori* proof thus becomes impossible, if the assumption of the fixity of terms is contested: all proof becomes, in a sense, empirical. *Was Aristotle anti-empirical?*

Nevertheless, experience shows that the fixity of terms, though not a 'fact', is a valid 'fiction': in ordinary discussion the terms may usually be taken as fixed enough to render valid syllogisms common. An ordinary debate proceeds upon the assumption that the meaning of the terms involved is fixed, and cannot be varied arbitrarily. To science, however, this assumption does not apply without restriction. In a progressive science the meaning of terms often develops so rapidly that such verbal reasoning does *not* suffice. Hence the mere occurrence of verbal contradictions in a scientific reasoning is no proof that the argument is unsound. It may show merely that its terms are *growing*.

It should be observed further that this same assumption is implied in the fundamental 'laws of thought' on which the traditional logic rests. Indeed, the notorious 'Law of Identity' seems to be merely another statement of it. It is usually formulated as '*A is A*', but in its actual logical use it is really the assumption that '*everything is what it is called*'. It is, of course, anything but self-evident that '*A is A*', but *unless* the *S*, *M*, and *P* of the syllogism are *rightly* so called, the syllogism will not

hold. Similarly, the Law of Contradiction collapses at once if the terms to which it is applied are allowed to change. The inability of 'A' both to be *B* and not to be *B* vanishes if 'A' is not fixed and may change its habits. And of course the real things known to science all change, and are fixed only by a fiction. Hence every application of the logical convention to real things may be challenged: it involves a fiction and takes a risk, and both of these may be bad. But the traditional logic ignores both the risk and the fiction and the lack of cogency in its attitude.

§ 8. (2) It is a further presupposition of the syllogism that the meaning of its terms is *known*. When a discussion is begun the parties to it are supposed to understand each other, and not to have first to find out and form the meaning of the terms they use. This assumption also is roughly true in ordinary debate, and its convenience is manifest. If things are rightly named, and if this feat has been accomplished once for all—presumably by Adam and Eve before they were turned out of Paradise for trying to know too much—we shall escape many of the most trying difficulties of scientific inquiry. We need no longer trouble whether the best names have been given, and whether a name good for one purpose is equally good for another, nor need we inquire whether our names may not unite what is alien on account of a superficial likeness, or separate what is akin on account of a superficial difference.

In science, on the other hand, the assumption that we know what meanings our terms can convey is not made as a matter of course. We may begin with roughly labelling objects of interest, and then inquiries may be conducted into, e.g., 'electricity', 'elements', 'life', 'species', &c., in the hope of settling what these terms *shall* mean, and of finding out *more* about their meaning, and without making the assumption that whatever new facts are discovered about them must conform to our preconceptions and confirm our nomenclature. Thus to a man of science it will not be cogent to argue that because an 'element' is (by definition) an ultimate form of matter which cannot be broken up, and 'radium' breaks up, 'radium' is not an 'element', or that because 'species' are eternal forms, and the Darwinian theory claims that they are not immutable, it can be dismissed as involving the 'contradiction' that a 'species' is not a species. Thus the best syllogisms lose their cogency so soon as a question is raised whether the verbal

identity of their terms is an adequate guarantee of the real identity of the things they are applied to.

§ 9. (3) It is a further presupposition of the logician's conception of 'proof' that absolute truths exist, and that in the ideal demonstration they form the premisses from which the conclusion follows. This presupposition is not stated, and is not implied in the form of the syllogism. For a syllogism is no less 'valid' if its premisses are true only hypothetically, and not absolutely. Indeed, it is not thought to impair the 'validity' of a syllogism that its premisses should be utterly false. At any rate we can *reason* quite as well with hypotheses and probabilities as with absolute truths, and this is in fact what we usually do, whether or not we are aware that our premisses are conditional and hypothetical. This ordinary practice, however, is resented by the traditional logic. For if our premisses are only hypothetically true, how can they lead to conclusions which can be declared absolutely true? And if our conclusions are not absolutely true, how can they be certain? Are they not bound to remain infected with the doubts which beset their premisses? ¹ As we value the certainty of our conclusions, therefore, absolutely true and certain premisses must be procured. If they cannot be procured, even the best formal proofs will remain hypothetical, and all truth will become dependent on experience. For if nothing is true absolutely, and every truth has originated humbly in a guess that has grown into a successful hypothesis, it can always be suggested that after all it may benefit by a little more verification. It may be true enough psychologically and for practical purposes, but it does not realize the ideal of 'logical certainty'.

§ 10. This ideal Logic has formulated from the first. Aristotle already was not content with merely analysing the form of reasoning; he aspired to formulate the norm of scientific demonstration. The 'demonstrative syllogism', which he held to be the form of truly scientific reasoning, differs from the formal syllogism in two essential respects. Its premisses are absolutely true, and its middle term states the real 'cause', which connects its terms and is not merely a *ratio cognoscendi*. The reasoning proceeds, therefore, from premisses which are unambiguous, true, and certain, i. e. *necessarily* true and *absolutely* certain. Nor does the conclusion lose any of this excellence. Logic puts on a fine air of modesty,

¹ Cf. §§ 10, 28.

and merely claims that the syllogistic form is a guarantee that no truth can be *lost* on the way from the premisses to the conclusion in a 'valid' argument. If, therefore, our thought is properly arranged, our conclusion will be as true and certain as were its premisses, and no man will be able to gainsay it. It is the great beauty and merit of the syllogistic form that it is an arrangement which gives us this guarantee.

It was natural, therefore, that throughout the history of logic enormous importance should be attached to the acquisition of unquestionable starting-points. For the possession of 'valid forms' was not enough. It only insured against loss of truth, it did not provide for its acquisition. It seemed, however, to imply that truth could only be generated out of truth, and handed down from the premisses to the conclusion. Hence the insistent demand for assured starting-points, self-evident 'principles', which the infallible method of syllogistic deduction might conduct to equally certain conclusions.

In reality, however, this demand for certainty was extralogical: it is not required for the purpose of analysing reasoning. For it is just as easy to reason from doubtful and probable premisses as from certainties, nor need the doubt in the reasoner's mind affect the form of the reasoning. If, however, there is an imperative desire for certainty, it must be somehow gratified by logic. And there seemed to be no way of doing so except by ascribing absolute truth and certainty to the initial principles of science.

Of course it was covertly assumed that certainty could only be reached by *starting* from certainty, and that no possibility of a growth of assurance in the progress of the reasoning could be entertained. In a sense this assumption was correct (cf. §§ 27, 28), because it is true that the gradual verification of scientific truths does not render them absolute; but it led to neglect of all methods which appeared to start with premisses initially doubtful and hardening into certainties by gradual confirmation. No doubt it was not strictly impossible to reason from premisses not known to be true, but such reasoning was despised as 'dialectical', and no inquiry was made into the frequency of its occurrence in actual science. Why, then, waste time upon so unworthy a procedure, instead of fixing one's whole attention upon the truly logical ideal, the absolute proof of absolute truth? Let us maintain,

rather, the old Aristotelian¹ conviction that the truly scientific syllogism proceeds from premisses that are true and underivative (because 'self-evident') and inerrant, and demonstrates its conclusion with ineluctable necessity! Thus the attainment of *absolute truth* was unobtrusively smuggled in as the aim of reasoning, and became an integral feature of the ideal of 'demonstration'.

§ 11. From the standpoint of the scientific inquirer, however, this whole theory of proof is open to the gravest objections. He finds first that it is impracticable, being composed throughout of counsels of perfection with which he cannot comply, and then that, even if he could, they would be perfectly useless, and destructive of his aims.

(1) It strikes him at once that the Fixity of Terms is an obvious *fiction*. He will of course be aware, from his scientific experience, that fictions have their uses and are often indispensable; but he will know also that not all fictions are useful, and that the adoption of a fiction has in each case to be justified by its usefulness. Moreover, it is not so much its immediate and prospective use which justifies it, though this yields the usual motive for its adoption, as the ulterior uses ascertained *ex post facto* by experience.

He will ask, therefore, for evidence that an *absolute* fixity of terms is the vital necessity for logic it is declared to be. He will admit, of course, the familiar arguments for a certain *stability* of meanings which have come down from the days of Plato, but he will suggest that a *relative* fixity of terms is quite sufficient to content them. He will point out that in a progressive science any absolute fixity in its terms is precluded by the very progress of the science. For the terms in use must somehow manage to convey the *growing* knowledge they are employed to 'fix'. The term 'gas', for example, must not be tied down to the meaning Van Helmont desired to convey when he invented it; it must incorporate all that physics has discovered about 'gases' ever since. Similarly, when Darwinism transforms the notion of 'species', and the discovery of radio-activity that of 'atom', these developments of meaning must be recognized as perfectly proper. To object to these conceptions as modern science uses them, on the ground that, because to Plato and Aristotle species were eternal and immutable, a 'species' that changes cannot be truly a species, or that because an 'atom' is etymologically

¹ *Post. Anal.* i. 2. 71 b 20.

'indivisible', it becomes an impossible self-contradiction when it is made up out of 'electrons', will seem to him to reveal only the fatuous pedantry of an utterly unscientific mind.

§ 12. (2) If he is acquainted with psychology, he will perceive also that the fiction of the fixity of terms is subject to a further restriction. It is not only in science as such—for all sciences must be conceived as progressive—that the fixity of terms cannot be made absolute: a real fixity is strictly inconceivable for and in every human mind. For every term that is actually used to convey a meaning must be held to form part of a *new* truth,¹ i. e. of a truth that was not previously in being. It is not a question of principle whether the truth is supposed to be new only to the person to whom it is addressed, or claims to be new to all, i. e. to science. For no judgement would be made unless it had something new to say.² Hence *every real judgement*, as opposed to the verbal formulas which are called judgements in the logic-books, *more or less modifies the meaning of its terms*. If it succeeds in being a real judgement and a new truth, it establishes a new and previously unknown relation between its subject and its predicate. 'S' is henceforth an *S-which-can-have-P-predicated-of-it*, and 'P' a *P-which-can-be-predicated-of-S*. Thus both the psychological associations and the logical associates of *S* and *P* are changed. That logicians should not have noticed so obvious a fact can be attributed only to their inveterate habit of not using in their illustrations real judgements intended to cope with actual problems, but operating with their verbal skeletons, which are not being used by any one to convey his meaning, and so do not have any *actual* meaning.

Clearly, then, no science can interpret the fixity of terms quite literally. Or rather, it can only interpret it literally—as a matter of the literal integrity of the *words* that *may* convey a meaning. But in a scientific inquiry the convention of formal logic must be reversed; the fixity of terms must be *understood not to be absolute*, but to be merely *ad hoc* and sufficient to convey a definite meaning, which it is desired to develop. Accordingly it must always be assumed that the results of an inquiry are to modify its terms, and that it is permissible, and indeed inevitable, to develop their meaning, so long as they remain capable of expressing and conveying the new truth. We must come to every

¹ i. e. truth-claim.

² Cf. *Formal Logic*, p. 173.

inquiry with a willingness to learn and to expand our terms. The Fixity of Terms, as it is tacitly presupposed in the traditional logic, is a scientific blunder of the gravest kind.

§ 13. (3) To renounce it, however, entails further consequences. It appears to undermine the whole notion of formal validity. For if we admit in principle that the meaning of terms depends vitally on that of the judgement in which they occur, how can we continue to rely absolutely on the mere verbal identity of its terms to hold together a syllogism? In any syllogism the middle term, *M*, may have one shade of meaning in relation to *P*, another in relation to *S*. It may be quite right to call *M P* in one connexion, and to call *S M* in another; and yet, when the two assertions are put together, they may lead to a conclusion which is an error or an absurdity. The man who (in his laboratory) would rightly declare that 'all salt is soluble in water' and (at his dinner table) as properly hold that 'all Cerebos is salt', could not combine these assertions to draw the conclusion that 'all Cerebos is soluble in water', without finding that the facts confuted his anticipation.

No doubt, when this had happened, he might explain it, *ex post facto* (if he knew logic), by alleging a hidden 'ambiguity of the middle term'. We need not here discuss whether it is fair to treat as an inherent ambiguity what is really a juxtaposition of shades of meaning which were relative to different purposes and right in their original contexts, thus manufacturing a fallacy by selecting the premisses: the important thing is that the logician should be driven to admit that *any* middle term may become ambiguous in this way when a syllogism is constructed, and that this completely stultifies his assumption that the *verbal* identity of the middle guarantees the *real* identity of the objects to which it refers.¹ If we call two things, which are and must be different if they are to be two, both '*M*', we necessarily take the risk that the differences are irrelevant for the purpose of our argument. We may legitimately assume this, but if we do, our hypothesis

¹ Mr. Alfred Sidgwick has been pointing out for the past twenty years how fatal this difficulty is to the traditional notion of formal validity; nor has any logician confuted his argument, or even shown that he apprehended its meaning and scope. It would seem, therefore, that the condition of formal logic is so precarious that its only chance of survival lies in hushing up all the vital objections to its stereotyped doctrines. But is not the policy of ignoring unanswerable objections the sure mark of a pseudo-science?

has to be confirmed in fact ; it is naïve to think that the verbal identity of the terms is quite enough. If, then, actual identity cannot be absolutely guaranteed, if there is *always* a possibility that the same term when put into a syllogism and used in reasoning may develop an ambiguity and become effectively two, it is evident that no amount of formal validity will safeguard the truth of a conclusion, even when the premisses are in themselves severally true. The syllogistic form is convicted of *losing* truth which it started from, and this is the very thing it boasted it could never do. Moreover, its coercive 'cogency' is exploded : whoever wishes to deny a 'valid' conclusion after admitting its premisses, has merely to suggest that by putting the premisses together a fatal ambiguity has been generated in the middle term.

§ 14. (4) The assumption that everything has been named rightly, and is what it is called, will scarcely commend itself to the scientific researcher. He will know from much painful experience that language only embodies the knowledge which has been acquired up to date, and too often is only a compendium of popular errors. Hence in any research which really breaks new ground the existing terminology will always prove inadequate, and new technical terms have usually to be devised in order to embody the new knowledge. The reason is obvious. *Ex hypothesi* we are inquiring *farther* into the subject, because our knowledge is felt to be insufficient. Accordingly the probable defects of the terminology we are initially forced to use must be borne in mind : we may expect it to omit what is unknown, to misdescribe and to classify wrongly what is partially known, putting together what does not belong together and separating what does, emphasizing the unimportant and slurring over the important, and generally failing to provide the mind with words that give it a real apprehension of the objects under inquiry. Hence the tacit assumption of Aristotelian logic that the terms reasoned with are fully known, that adequate notions are already extant, that truth has merely to be *disentangled* by a verbal criticism of existing opinions, and has not to be discovered outright, is false ; nor can any argument from a verbal identity be taken as final.

§ 15. (5) But of all the assumptions lurking in the theory of proof, the belief that reasoning can and should start from certainty will seem the falsest and most pernicious to the man of science. For it means that we are committed to a search for absolutely

certain premisses as a preliminary to every inquiry, and proscribes consciously hypothetical, i. e. truly experimental, reasoning altogether, or at least condemns it as incapable of leading to certainty. This search, however, will either be perfunctory and uncritical, if it accepts false claims to certainty; or else vain, if it is conscientious. For every attempt to prove a conclusion absolutely demands *two* absolutely true premisses; hence the more we try to prove, the more we have to prove, and our search grows the more endless and futile, the longer it is continued. An immutable basis of absolutely certain truths, therefore, for reasoning to start from, is nowhere to be found. In no science is it possible to start with truths that are absolutely certain. In every science the initial 'facts' are doubtful; they are alleged, but not yet approved. They embody only unsystematic observation and prescientific experience of the subject, and so are probably the products of inaccurate observation, bad interpretation, false preconceptions, and popular superstitions. To acquire any considerable scientific value, such material has to be thoroughly revised and refined.

The validity of methods and the certainty of 'principles' are no more assured than the 'facts', initially. Every science has to work out its own appropriate methods experimentally; even if it borrows methods from another, it has to find out how and how far they apply to a new subject. Neither does a science acquire its principles by divine revelation; even if they fell from heaven ready-made, it would insist on testing the authenticity of the revelation. But philosophers have been extremely reluctant to admit that the certainty of principles is a gradual growth: for over 2,000 years they have been endeavouring to discover some way of securing an infallibility to principles which would render them independent of the working of the sciences which use them. But if their labours have proved anything, it is that no such way can be found.

(a) They have recognized many principles as '*self-evident*', and equipped the mind with a variety of 'faculties', expressly invented to enable it to apprehend the 'self-evident' inerrantly. But they have not been able to agree upon a list of self-evident principles,¹ nor even to find any truth whose claims to self-evidence have not

¹ The latest I have noticed occurs in Abercrombie's *Inquiries concerning the Intellectual Powers* (1830); it reads very strangely now.

been denied by competent critics. Nor have they been able to define their notion of 'self-evidence' itself; they cannot discriminate between the sound 'logical' self-evidence, which they conceived to guarantee truth, and its merely 'psychological' 'mimic', which is certainly much commoner, and becomes more intense and extensive the more unsound is the mind that 'apprehends' it.¹ Hence an unprejudiced observer has no reason to put the 'intuitions' of philosophers and the 'faculties' which apprehend them on a higher cognitive level than those of women or even lunatics. They all impose themselves psychologically; but this proves nothing as to their logical value, and science has to test them just the same.

(b) The principles which are said to be *necessary* or *logical* 'presuppositions' all turn out to be hypothetical when they are examined. They are needed, no doubt, to solve the problem in hand, *if* the particular way it is formulated is taken for granted. But if either the order or the formulation of problems is altered, they cease to be either 'necessary' or 'presuppositions'. For example, the 'axiom of parallels', *alias* 'Euclid's postulate', is a necessary presupposition of geometry, if the existence of parallels is assumed. But if we prefer it, we can just as well (with Aristotle) make it our axiomatic 'presupposition' that the interior angles of a triangle are equal to two right angles, and can then deduce the existence of parallels. I. e. Euclid might have deduced what he assumed, and assumed what he deduced. If, moreover, we do not desire to construct a Euclidean geometry at all, we can deny *both* presuppositions, and proceed from *alternative* postulates, which lead to the various metageometries. The only things, in short, which all scientific principles presuppose are the desire to construct a science, and the desire to construct it in a particular way, which is simplest, or easiest, or most systematic, or most in accordance with the reigning prejudices. But these desires are the very things which the logician's account of principles always omits to mention.

Again, the whole of Kant's scheme of *a priori* presuppositions in the theory of knowledge rests upon an arbitrary assumption, viz. that mental data are to be conceived as originally discrete and are therefore in need of 'synthesis'. But it is just as possible

¹ Controversially the criticism of 'self-evidence' has been met in the same way as that of the 'validity' of the syllogism, i. e. by total silence.

to conceive an analysis of knowledge which starts from the 'pre-supposition' of a continuum or flux, and proceeds to trace out the principles by means of which this continuum is broken up into a world of apparently distinct things and processes. Nor is it possible to say in advance of experience which of such 'presuppositions' is going to be more convenient and more conducive to scientific progress.

(c) It demands a high and rare degree of philosophic insight to perceive that very many principles are neither certain, necessary, nor probable, but simply *methodological*. Whether we think them true or not, we adopt them because of their eminent convenience. If they turn out to be false, candour compels us to call them *methodological fictions*; but they continue in use. Our belief in the trustworthiness of memory is a good example. For though we often find that our memory has played us tricks, we continue to accept as true what we 'distinctly remember'. If no limitations to the truth-claim of such assumptions are discovered, enthusiasts will probably insist on promoting them to the rank of indisputable 'axioms', and hail them as absolute truths. But their scientific value is not thereby enhanced, and the cautious will eschew such exaggerations. For there is no real reason why the scientific rank of principles should not rest openly and entirely on their actual services, and why a 'methodological assumption' should not rank higher than a 'self-evident truth'. For the latter is at most a fact of our mental organization which nothing has so far turned up in nature to set at naught, and as such a fact it is itself a thing to marvel at rather than an explanation of other things. The scientific spirit will always hesitate to acquiesce in the limits which are set to inquiry by sheer brute facts, and if the absolute truth of certain principles were merely an ultimate fact which could neither be impugned nor explained, this would go far to make these principles appear unintelligible and would be a constant challenge to dispense with them, or somehow to evade them. A principle, then, should always be prepared to state the reasons a science had for adopting it: only the reasons will appear from the actual working of the science. They will involve a reference *forward* to the facts it copes with, not *back* to higher principles or to any claim that proves itself by its self-assertion.

(d) Indisputable principles, then, are not consonant with the

spirit of inquiry: it will gladly let them go, if it can attain truth and advance knowledge in other ways. It will not shrink even from repudiating the ideal of absolutely true and demonstrated truth, if it can be realized only by sacrificing the progressiveness of science; nor will it be dismayed to find that this ideal is unrealizable. For when the inquirer reflects upon his own procedure, he finds that it points to a radically different ideal, and that the existence of absolute truths would only be a hindrance and a restriction upon his endeavour (cf. § 28 (4)).

II

§ 16. Before, however, we attempt to delineate the logical ideal of the discoverer, it will be necessary to encounter a serious objection which protests on principle against such an undertaking, and urges that discovery by its very nature must elude logical treatment. It is contended, in the supposed interests of logic, that discovery is a process so inherently and incurably psychological that no logical account can ever be given of it. Discoveries are windfalls, and come as 'happy thoughts' to the gifted geniuses that make them, in a manner neither they nor any one else can account for or describe: they are therefore logically fortuitous, and to set forth the ideal of proof by which the truth of discoveries is tested is all that need, or can, be the concern of logic.

Certainly the great majority of deductive logicians have taken up some such attitude towards the process of discovery. Aristotle contents himself with a bare mention of 'sagacity' (*ἀγχινοια*), which is defined as the instantaneous apprehension of the suitable middle term for constructing a demonstrative syllogism.¹ When one recollects the weary centuries of painful effort and continual failure which elapsed while the *élite* of the human race were seeking for clues to, e.g., the mysteries of disease and of physical happenings, before they hit upon the notions of microbes and the mechanical theory, this naïve underestimate of the most difficult and essential of scientific procedures sounds like a mockery. Yet the whole Aristotelian school pass over the problem as lightly. They all seem to believe that while it is merely low cunning to make a discovery, it is a real proof of mental capacity to arrange

¹ *Anal. Post.* i. 34.

it 'in logical order' after it has been made, and to show how far short it falls of the logical ideal. Even the inductive logicians may be said to have participated in this attitude. For they were not more anxious to propound methods of discovery than to contend that their conclusions were just as rigidly proved and just as formally valid as those of syllogisms. They did not see that they were thereby accepting the demonstrative ideal of proof and giving away their own; what they should have shown was that this ideal was utterly nugatory, and that their own methods could never conduct to 'proof', but only to something vastly superior.

§ 17. In spite, however, of this wonderful consensus of logicians the above argument depends essentially on a confusion. It has confused two things which are perfectly distinct, the actual procedure of the individual discoverer, and the generalized description of the attitude of mind and procedures of discoverers, as they appear to subsequent logical reflection. Both present problems to the logician, but the problems are not the same. To anticipate the process of actual discovery may well be left to the prophets; it will transcend the powers of logic and indeed of any science, unless it be individual psychology, if it exists, or history, if it be a science.¹ It may readily be admitted that anecdotes about the bath which fomented in the mind of Archimedes the idea of specific gravity, and the streets of Syracuse through which he ran and cried '*Heureka!*', or about the apple-tree which shed its fruit upon Newton's receptive head, and stimulated his brain to frame the law of universal gravitation, are beneath the dignity of science. Their narration belongs to history, which can go as deeply into their details as the scale of the history and the purpose of the historian demand; but the particular circumstances of a particular discovery may well be treated as 'accidental', and be smoothed out of the scientific record. But why does it follow that no common features can be traced in these histories of discovery, and that there cannot be compiled out of a sufficient number of them a generalized account of what appears to be the 'essential', i.e.

¹ It may be suggested that there is a similar confusion on this question: when history is called a science, it is often forgotten that its data are essentially such that they can only occur once, while the material of the other sciences is such that cases of 'the same' may always be found in it. But neither need it be denied on this account that history can, and should, be written in a scientific spirit.

really relevant, procedure of discoverers, which may serve as a guide and model to subsequent discoverers? Why should this be more difficult than to describe the method of lion-hunting from the records of lion hunts, or the treatment of a disease from the history of a number of cases? Indeed, it would seem that the thing has been done. Any discoverer may reflect upon his own discoveries, and, like Poincaré,¹ formulate the method he has found successful. And if discoverers are not all perfectly unique in their methods, important uniformities will probably be found by comparing the methods of a number of discoverers.

Why again should it be assumed that the general account thus extracted from a retrospective study of discoveries must at once coincide with the logical 'ideal of proof'? Why should it even point to this, or be related to it otherwise than by contrast? Surely the possibility should be discussed that there are *two* procedures for logic to consider, of which the one describes how human knowers, starting from what they believe themselves to know, set about it to fortify and extend their knowledge, while the other moves on a superhuman plane and describes, with Platonic fervour, how ideal demonstration, descending from absolutely certain principles, moulds into a closed and inexpugnable system all the truths which are deducible from these and alone intelligible. The two accounts must be distinct, for they have different starting-points and work upon different material. Nor need they ever have any point of contact. For it may well be that human knowing never attains to an absolute certainty and a completed system, while deductive proof never condescends to notice mundane fact.

This was certainly so in the first rapturous vision of *a priori* 'proof' which solaced Plato amid the elusiveness and opacity of the flow of happenings. The deduction of the intelligible order of the ideal 'Forms' from their supreme ground and (*sole!*) premiss in the 'Idea of the Good' stopped short of facts and events at the *laws* of minimum generality,² and recognized in all the happenings of the sensible world an ineradicable taint of 'not-being' which rendered their stability impossible and their prediction vain. Aristotle similarly distinguished between the procedure which started from the *notiora nobis*, the apparent facts

¹ *Science et Méthode*, ch. iii, L'Invention mathématique.

² *Republic*, 511 c.

of perception, and that which began with the *notiora naturae*, the self-evident principles which could form the ultimate premisses of demonstrations. But that these two methods must somehow coincide was assumed rather than proved, in a way that should have discredited the doctrine. For Aristotle also was not able to explain how 'science', being of 'universals', could apply to particulars, which nevertheless he would not with Plato stigmatize as 'unreal', while the ascent from the sensible fact to the 'universal', which was called the 'induction' of the 'principle', is hardly validated by the naïve allegation of a mental faculty of 'intuitive reason' (*νοῦς*) endowed with the special function of apprehending principles in their particular exemplifications. It is high time, therefore, that this whole assumption that a necessary congruity exists between the logic of discovery and of proof should be subjected to a thorough examination.

III

§ 18. Such an examination will speedily establish that the mental attitude of the discoverer is, and must be, quite different from that of the prover.

In the first place, the discoverer is not in possession of the knowledge he covets. It is for him a desire, an aspiration, an aim to be attained. Proof, on the other hand, presupposes knowledge. Not only must the demonstrator *know* the assured truths he uses as premisses, not only must he have a supply of absolutely certain truths if his proof is not to remain hypothetical (§ 9), but he must already know the conclusion he exhibits. He cannot be ignorant, like the discoverer, of the result he is to arrive at. He is not engaged in *discovering* new truth, he is only showing how it *follows from* old truths. His retrospective contemplation has merely to retrace the history of its attainment, or rather to rearrange it in the more pleasing order which he calls 'logical'. This order is not that in which it *was* discovered, nor even that in which it *could be* discovered. For there are such things as necessary errors, indispensable artifices, and indefensible fictions, and the way to a truth often lies through them. Thus from time immemorial mathematicians have represented the continuous by the discrete, quantities by numbers, knowing full well what fictions their practice involved. Again, mathematical calculation of shapes, areas,

and motions necessarily presupposes the fictions that bodies have the ideal and regular forms to which they 'approximate', and that their 'mass' is concentrated at their (ideal) 'centre of gravity'. It is more than doubtful whether the notion of an 'evolution' of species could ever have been reached, except by starting from the false notion of the fixity of species, or whether the true nature of the mobility and development of meanings could have been understood except by correcting the Platonic theory of immutable and eternal 'universals'. To 'proof' all these incidents and accidents of the history of discovery are irrelevant; all that has to be done is to show that the new truth can be deduced from the old, and that a 'logical connexion' exists between them.

§ 19. Not only is this much easier to do than to make the discovery, but it is very much easier to follow. Any one can see the connexion once the data have been arranged in logical order. Hence the assumption that this order somehow represents the actual process in a perfected form is natural enough. But it leads to contempt for the procedure of discovery. The discovery is made to look so easy that it becomes impossible to appreciate its difficulty and its merit, and it seems astonishing that no one made it long before. For did not the 'facts' all but force it upon the dullest mind? Who could have failed to see that fossils must be (at least) as old as the rocks in which they are embedded, that obviously worked flints, similarly, attest the antiquity of man, that northern Europe is scratched all over with the marks of a gigantic glaciation? It is forgotten that these 'facts' were *not* there until there came a mind prepared to notice them. Hence none of these discoveries were in fact easy to make, and they were preceded by a long struggle of the human mind with false pre-conceptions and the illusory 'facts' which they had engendered.

Nor are discoveries easy to get recognized when they have been made. The persecutions to which discoverers of new truth are subjected always and everywhere (more or less) form as discreditable a chapter of human history as the persecution of moral reformers. Those may count themselves fortunate who are simply ignored. Hence everything has to be 'discovered' over and over again. Nothing new ever enters the world, just as nothing old ever passes away, without infinite pains and after a protracted struggle. One curious result of this inertia which deserves to

rank among the great fundamental 'laws' of nature, is that when a discovery has finally won tardy recognition, it is usually found to have been anticipated, often with cogent reasons and in great detail. Darwinism, e.g., may be traced back through the ages to Heraclitus and Anaximander. Thus it is true that there is 'nothing new under the sun'; but only because when a new truth first appears it does not prevail: when after a hundred repetitions it is at length recognized, it is no longer strictly *new*. Accordingly, the 'discovery' of a truth is only the beginning of its career, the first step by which it makes its way in the world, and still very distant from the crowning 'proof' with which logic complacently adorns it *ex post facto*, when it has 'arrived'. The slowness and difficulty, then, with which the human race makes discoveries, and its blindness to the most obvious facts, if it happens to be unprepared or unwilling to see them, should suffice to show that there is something gravely wrong about the logician's account of discovery.

§ 20. Quite apart from the difficulties which the psychological constitution and social organization of man put in the way of innovators, the making of a new truth which formulates a new 'fact' is also intrinsically anxious work. It is not merely that its maker can have no assurance that his enterprise will succeed, that he cannot start with a feeling of certainty from established truths, and be wafted by an irresistible wave of logical necessity to the safe haven of a predestined conclusion. He *must start with a consciousness of ignorance and an all-pervading feeling of doubt about every step of his inquiry*. This doubt he should not, moreover, endeavour to disregard or to suppress; for it is the best guarantee that no way to the truth will be passed by in his explorations. Doubt, therefore, should be recognized on principle, and equipped with a technique of testing and experimentation: the inquirer should be proud that he has to feel his way in fear and trembling to the very end.

Yet his condition will not contravene Aristotle's dictum that all inquiry and research proceed from knowledge previously acquired.¹ In a sense he will still start from what he knows, or thinks he knows. For it is psychologically impossible to do anything else. The knowledge he believes himself to have cannot but affect all his ideas, and he cannot get away from it. His

¹ *Anal. Post.* i. 1.

boldest speculations, his most hazardous hypotheses, will have *some* relation, however subtle and recondite, to the knowledge at his disposal. It will influence all his thoughts and guide his guesses. As he cannot divest himself of his knowledge and the ideas it has rendered familiar to him, he has to accept its limitations. His only problem is to use it as effectively as possible.

But it is clear that he cannot regard his knowledge with the same sort and amount of confidence as the believer in demonstrative proof. He must conceive himself as an explorer, and his attitude must be tentative throughout. Knowing that his premisses are questionable and only doubtfully true, he will recognize that his inferences are only probable, and stand in need of confirmation. As a rule he can, no doubt, find accepted truths to argue from; but these being relative to the existing state of knowledge are known to be subject to correction. Even where he has started with premisses of the most superior kind, which are generally deemed absolutely self-evident and certain in themselves, he will still be conscious of a doubt whether they will prove to be the right premisses *for his purpose*. If they are not, their truth is irrelevant and will lead him astray. In no case, therefore, can he escape the responsibility of *choosing the right ones* from his limited stock of known truths and familiar ideas, as he contemplates the infinite expanse of possible discovery. In whatever direction he moves, the unknown lies before him; he may come upon surprises or be stopped by unsuspected obstacles. In short, there is nothing of the irresistible about his progress; it has not the faintest resemblance to the majestic march from inevitable premisses to a predestined conclusion which so fascinates us in the theory of proof.

§ 21. But, it may be said, all this is not enough. The differences in the attitudes assumed by the reasoner in discovery and in proof may be only psychological. They do not prove any real logical difference between them; the logician's account may still be what the discoverer would acknowledge to have been his best course, if he could have seen it. It has, therefore, to be shown that the differences in question arise out of, and develop into, differences which are indisputably logical.

Thus, the ignorance which the inquirer feels is doubtless a psychological fact, but the lack of knowledge which engenders it is surely a logical fact of some importance. In general, the feelings

of doubt, expectancy, and perplexity which beset the mind of the inquirer, and contrast so distinctly with the feelings of confidence, knowledge, certainty, and necessity which accompany a 'proof', originate in a logical fact. Every inquiry starts from a problem, of which the solution is not yet known. An *inquiry* is, as the name implies, a *question*, put, not to nature at large and at random, but to some *part* of it, which is taken to be relevant and to contain a possible answer to the inquirer's question. Now this dependence of inquiry upon problems springs no doubt from the psychological fact that until there is something put before it the mind cannot get to work upon it; but it is surely a fact of the utmost logical significance, and it is astounding that the logical tradition should have slurred it over so completely.

Especially as in the very beginnings of logic some of the Greeks distinctly caught a glimpse of it. For, having started their reflection upon reasoning from a desire to regulate debate and to argue a case at law, they naturally noticed that there are two sides (at least) to every question. Accordingly, Protagoras appears to have taught systematically that there were always two reasonings (*λόγοι*) to be considered,¹ Socrates treated scientific inquiry as an extension of the art of cross-examination, and Plato conceived the search for ideal truth as a 'dialectical' process, as a sort of dialogue of the soul with itself. Now this whole doctrine is equally good as logic and as psychology. It is profoundly true of the inquirer's mind; he must be keenly alive, not only to the evidence *for*, but also to that *against* his working theory. But it is also true of the logical nature of inquiry that it is a process of determining *which* of the alleged 'facts' and of the theories to interpret them are real and true. Inquiry logically 'presupposes' a conflict between the data, and a dispute about them.

Unfortunately, however, the conception of scientific research as an inquiry lapses from the logical consciousness in consequence of Aristotle's work. His discovery of the forms and formulas of demonstration overshadowed it, and restored the reign of dogma which is so congenial to the authorities everywhere.² The true conception of inquiry does not revive again until our days, when Mr. Alfred Sidgwick and Professor John Dewey have endeavoured, not with the success they deserved, to reopen the eyes of logicians to the facts of the scientific situation.

¹ Diogenes Laertius, ix. 51.

² Cf. § 3.

§ 22. To conceive an inquiry as a question then is, we see, implicitly to conceive it as having a plurality of answers, all of which have to be examined. All these answers are initially hypotheses, and a choice has to be made between them. This renders the recognition of alternatives a paramount necessity for a logic of discovery, which can no longer dismiss them with a jejune chapter on 'disjunctive propositions'. Their existence is no longer to be treated as an annoying complication which delays the progress of science, but must be taken to inhere in the logical nature of problems, and to be essential to their proper elucidation.

Logic, therefore, should regard it as its duty to inquire (1) how the inquirer is furnished with an adequate supply of theories for analysing and testing the apparent facts of his subject, (2) what methods are used to sift hypotheses and to select the more valuable, and (3) if it can, to add some hints as to how theories and methods *ought* to be handled.

(1) To the first question there is no exhaustive answer. No logic can guarantee that *all* the possible theories which concern the facts under inquiry will be available. They may not yet have occurred to any human mind, and may never do so. This alone ought to be considered a fatal objection to all methods which presuppose exhaustiveness, and are pressed by the logician upon the man of science. It ought to dispose of methods which demand that *all* the facts should be assembled before theorizing is begun, or that *all* the alternatives should be stated and the true one extracted by the successive elimination of the false ones, or that define a 'cause' as reciprocating with its 'effect', and assume that the true cause has been discovered when no other has been thought of, or that if a theory works we may take it that it alone will do so and is (absolutely) true. All these notions demand an impossible exhaustion of the alternatives, and try to convert a (psychological) failure to think of any more into a logical proof that there are no more. And they all regard the plurality of alternatives as a hindrance to be got rid of, and not as a safeguard and a help to proper inquiry.

Hence the real difficulty was not perceived, viz. that there is no formal guarantee that the supply of hypotheses for use upon the facts in any inquiry will be adequate. It may well be that for lack of a good working theory to go upon, all the theorizing on a subject proves vain and sterile. In the beginnings of all the

sciences this sort of condition always exists and often lasts for centuries, and it is a main reason why some sciences make little progress even now.

Nevertheless, the difficulty is not in practice as fatal as it looks on paper. It is probable that the inquirer will in fact usually have a supply of alternatives to start from. For (a) he will naturally select a subject in which there are disputed points. And (b), what is even more important, human minds are naturally various: they put, therefore, different interpretations on the same facts and value them differently. Some are attracted by novelty, others by orthodoxy; some incline to one type of theory and method of inquiry, others to another. Hence in any inquiry upon which a number of minds are actively engaged, there will always be differences of opinion, and these will be most marked in the rapidly growing regions of every progressive science, which, like the growing cells in the trunk of a tree, are always on the outskirts. There will always be a conservative and a liberal party, even in science, and the clash between their views will always provide alternative solutions of problems, the comparative merits of which the inquirer can examine. But the sciences owe their progress largely to the man who raises new questions, and should provide for him in their organization.

§ 23. It should be noted further that if this feature in discovery were properly recognized and emphasized, it would have important educational and ethical effects. At present the study of logic can hardly be said to liberalize and broaden the mind or to improve the temper. So long as its chief interest is in a theory of absolute proof and complete certainty, it will tend to breed pedants and bigots. The effect would be very different if an adequate logic of discovery had imbued the mind with an ever-present thought that every subject may and must be considered from several points of view, and that an inquirer should beware of letting his predilections and preconceptions blind him to possible alternatives. The logical attitude of inquiry, when fully understood, demands a tolerant and open mind, and excludes the narrow-mindedness and dogmatism which the theory of proof has fostered by its pretence of showing that there was but one truth and one inevitable way of reaching it. Moreover, the necessity of continually choosing between a number of alternatives should cultivate a judicial temper, conducing to fair-mindedness and consideration towards

the views of others. For a mind which is in the habit of choosing between alternatives must be impressed by the facts that there is something to be said for the views it does not accept, that the view accepted is often not so very much superior to those rejected, and that new facts and new knowledge may always revive views which were supposed to be defunct.

Of course our natural dogmatism will take alarm at the flabby toleration of ideas which this attitude seems to imply. It will be objected that no one who can see the good and truth in beliefs he does not accept, can really be strenuous in upholding those he does. The full answer to this bigots' argument can only be appreciated when the attitude of progressive science is fully understood (cf. § 33), but in general it may be pointed out that a power of first weighing alternatives, choosing the best and acting upon it strenuously, is precisely what life demands of us at every step. It should not, therefore, be impossible to compass it in science.

§ 24. (2) To the second question of § 22, viz. what are the methods used by the inquirer in sifting the alternative hypotheses in the field, and picking out the most valuable, the answer is comparatively easy. It is substantially the answer given by the pragmatist analysis of knowledge. That theory is preferred, and tends to be accepted as true, which for the time being *works* best. The formula looks simple, but needs more thinking out than its critics usually bestow upon it.

(a) It implies, of course, that *all* the alternatives (before the mind) 'work' more or less. They must be (or appear) scientifically plausible, and proffer a more or less satisfactory explanation of some or all of the admitted 'facts'. This is why agencies like the Devil, who could once be extensively alleged to explain anything unusual, have dropped out of the purview of science.

(b) 'Working' must be conceived somewhat widely. Its *primary* appeal is to the accepted principles and recognized interests of the science; practically to 'work' means to conduce to the development of the science on the recognized lines, and the proper judges of what 'working' counts are the experts who cultivate each science.

(c) But there will often be complications due to certain disputable workings, of which the relevance is not yet established, and about these there will legitimately be differences of opinion. These should not be suppressed, but candidly argued out.

(d) Moreover, every *new departure will be pro tanto* disputable, because it will conflict more or less with the vested interests of the established doctrines. One great factor in the 'working' of a new truth is the extent to which it upsets, or is thought to upset, the old, and demands a reconstruction of beliefs, a correction of authorities, a revision of text-books, a renewal of plant, &c. Hence what works best in the abstract may not do so under the actual conditions. It may 'pay' a professor better to be 'orthodox' than to be an innovator, and he is usually quite alive to this, though it does not render him a good investment scientifically for the institution that appoints him. If then we looked at this side of the matter alone, the verdict would always go against the novelty. For very few new truths are fortunate enough to find the field free and unoccupied. Usually they have to spring up in a soil densely overgrown with a rank growth of prejudices, dogmas, and superstitions, to which the world is accustomed and even devoted. So they have to fight for an opening in which they can take root and grow up.

(e) The 'working', however, need not amount to a claim to represent 'the' truth. A discoverer may know that by reason of his deliberate use of fictions, his results have forfeited their claims to be strictly true; yet they may 'work' better than anything else in sight. The typical example here is, of course, mathematics. When physical objects are treated mathematically, they are identified by a fiction with the objects of pure mathematics, and it is only on this assumption that their behaviour can be calculated. They are, of course, vastly *more* than mathematical objects, but their surplus meaning becomes irrelevant wherever objects admit of mathematical treatment. And apart from the restriction of the claim to truth necessitated by the use of fictions, it should, of course, be recognized also that there are sound logical reasons for denying that truths which rest on their 'workings' can ever be 'absolute' (§ 26 *s. f.*). Their truth is pragmatic, and is *optimi iuris* only if pragmatism establishes that no other and no better truth exists.

(f) More specifically a very important form of working is the prediction of events. Knowledge of the future is an almost universal object of human desire, which men have sought to compass by fair means and foul, and the calculation of the future is the avowed aim of many scientific inquiries. Hence there is nothing

more potent to dispose the mind to accept a theory than the success of the predictions it has led to. Yet here again this form of 'working' differs generically from 'proof'. It is clear that prediction is not strictly proof. For predictions may be made with considerable accuracy by the aid of hypotheses which turn out to be false or impossible. Thus eclipses and other celestial events were predicted for centuries by means of the Ptolemaic astronomy, and they cannot be predicted even now with absolute accuracy. Indeed, physically speaking, absolute accuracy is unthinkable. No instrument and no organ of observation can be conceived to measure to more than a finite degree of accuracy, and the *best value* for any physical 'fact' will always be the mean of a number of good observations after all the accessible sources of error have been allowed for.

At no point, then, does the test of 'working' conduct to the notion that absolute truth is discoverable. But the right inference may be, not that the test is worthless, but that absolute truth is a chimera.

§ 25. (3) It cannot then be seriously disputed either that alternative hypotheses are always (more or less consciously) present to the mind of the inquirer, or that the working of a theory is in fact used, in all the sciences, to test its claim to be true. But does it follow that logic should bow to scientific fact and recognize these practices? Should it set itself to devise a *technique* for regulating the formation of hypotheses and the establishment of their truth by their working? It is here that the traditional logic demurs, and disputes begin. Nevertheless, strong reasons may be advanced for answering both questions in the affirmative.

(a) An abundance of hypotheses is a guarantee of great logical value that all the important facts will be properly observed. For it is evident that every theory will produce a certain *bias* in the observer. It will direct his attention upon those facts and those features which are *relevant* to his theory, and, more particularly, which *support* it. This is usually an advantage, because it helps him to select what is relevant to his inquiry from the chaos of events; but it will *pari passu* blind him to whatever does not seem to be related to, and to fit into, his theory. He will, therefore, fail to observe and to appreciate what will seem to him to have little or no scientific interest. And in so thinking he may be quite wrong.

The old theory of 'induction' thought to get over this difficulty by saying, 'Well, of course, *all the facts must be observed*'. It did not observe the fact that in practice this is impossible, and is never done. Nothing is observed but what the knowledge and preconceptions of the time make visible to the scientific eye. Of what is visible at any time only a small part seems worthy of the scientific microscope. Complete observation, therefore, of literally all the facts is scientifically impracticable.

As a logical ideal also this notion of all-inclusiveness is absurd. If no inquiry could ever begin until *all* the facts had been assembled, how could anything be discovered until omniscience had been achieved, i. e. when there was nothing left to discover? For how are we to know that our assembly of 'facts' really is complete? And if literally all the facts have to be used as data in any inquiry, shall we not speedily find that every fact ramifies into infinity, and drags in the totality of reality, and a knowledge of all things present, past, and future? This 'logical ideal', therefore, renders inquiry impossible.

In point of fact the data of any inquiry are always a *selection*. They are such of the recognized facts as are thought to be *relevant*, i. e. to be truly 'facts' for the purpose in hand. But being a selection they involve us in the risk that we may have selected *wrongly*, and omitted what is important while admitting what is not. *From this risk there is no escape*. For we cannot effect a compromise by including merely so much of the facts as we can lay hold of. Not only does this yield no guarantee that everything that is needed has been included, but it may be a positive hindrance to try to include too much. For if our data grow into an unwieldy mass, they will not seem susceptible of any order or principle, and even the most penetrating inquirer will lose his way.

It is better, therefore, to give up altogether the idea of securing formal validity by postulating an all-inclusive exhaustiveness. The obvious alternative is to operate simultaneously with a plurality of theories, each of which means a certain ordering of the 'facts' relatively to what seems a relevant and promising point of view. Each will involve a selection and induce a bias; but with any luck they will neutralize each other's bias, and so will increase the probability that no really relevant fact has escaped notice. This will not satisfy the logical 'ideal', but in practice it means a good deal, and is enough for scientific progress. Of course

it must be understood that the hypotheses employed are in a general way relevant to the problems and the condition of the sciences, and not random guesses. This proviso will cut down their exuberance even more than the limitations of the human imagination, which seems to be psychologically incapable of really departing very far from the suggestions of experience.

§ 26. When logic has recognized the use and value of 'working' as the test of truth, it must, however, make it clear to itself and to others both what precisely this test is, and what it can, and cannot, accomplish.

In the first place, it must be made clear that it is not a logical implication of the test that 'whatever works is true', and the reasons for disputing this dictum must be set forth. The fact is that we all have a strong psychological tendency to believe in the truth of what is found to work, without much criticism of the sort and extent of the 'working'. But the logician should carefully investigate the various sorts of working that occur, and take special note of those which either do not themselves lay claim to full truth, or do not (ordinarily) have their claim conceded.

For example, 'fictions' are not supposed to be strictly true; but they may 'work' and be 'as good as true', or 'pragmatically true', or 'sufficiently true for the purpose in hand'. They work, in fact, within limits; but these limits are known, and so they are not confused with full-fledged truths, to the applicability of which there are no known limits.

The case of 'methodological assumptions' is more difficult and instructive, and is usually misconceived. In their case the existence of limits to their 'working' is either not known or not relevant, because they owe their adoption to their use and convenience in analysing and organizing a subject of inquiry. Thus the principle of Causation, the assumption that every event has a cause which determines it fully, is properly to be regarded as methodological. It declares merely that if we desire to calculate the course of events, it is scientifically convenient to treat events as if they had 'causes', from which their occurrence could be predicted, whether or not they have them in fact. This assumption may be purely methodological; it need not, and should not, be turned into a dogmatic, metaphysical denial that there may be indeterminate happenings. There may even be good reasons to suspect their occurrence, and indeterminism may be ultimately true, and yet

scientific method may rightly ignore this possibility, because it would render the calculation of events impossible.¹ Even an indeterminist then is fully entitled to reason *as if* events were determined, and to search for 'causes', for the purely methodological reason that this enables him to calculate events, and that after all they may be calculable. So long as they work for scientific purposes it is not, in the case of methodological principles, necessary to raise the question of their metaphysical truth.

The 'lie' again is a curious case of 'working'. A lie works, as a rule, only so long as it passes for truth, and is believed to have the meaning and value its author claims for it; when it is 'found out', it ceases to work. Hence it can both work and fail to work at the same time, according as it is, or is not, known to be a 'lie'. Clearly nothing can be made of the lie logically, until this double aspect inherent in its nature is recognized; if the logician refuses to distinguish between the *persons* concerned in its making, acceptance, and rejection, it remains (like 'error' to Plato) an insoluble 'contradiction'. It is, however, a mere prejudice to refuse to make these distinctions.

The 'working' of hypotheses is by no means simple and unambiguous. It admits of infinite gradations in amount and kind, and the 'truth' which is implicated in 'working' is nothing essentially but an index of its logical value, and may vary in quantity between values which cannot be *psychologically* discriminated from zero and from 100 % or 1 (= 'absolute' certainty). It is crude, therefore, to confront a scientific hypothesis with the rigid alternative 'either (absolutely) true, or (utterly) false'; its 'truth' really rests on its greater value, as compared with its competitors. Its value, then, is a question of more or less. The more extensively, conveniently, and economically a hypothesis works, the more value has it, i.e. the more likely is it to be called 'true', and to be supposed true absolutely: the more continuously and successfully the test of working has been applied to a doctrine, the greater the confidence and affection with which it is regarded, and the greater the presumption that it will continue to approve itself as true.

But, as we anticipated in § 24 (*s.f.*), it is vain to expect to establish any absolute truth by this method. It provides truth

¹ Or more difficult, if the indetermination is conceived as limited.

with ever-growing probability, but never with absolute certainty. For, however well a theory works, the thought that one may hereafter be found to work better can never logically be excluded. Even if every one alive were perfectly satisfied, and no one could imagine any improvement in an accepted truth—and these conditions are by no means often realized—such psychological considerations would not disprove the logical possibility that the best known was not the best absolutely, and logic would continue to distinguish between a truth that was absolute, and one liable to one billionth chance of error. The latter chance could be disregarded for all practical and scientific purposes, and would not have the slightest psychological effect on the confidence with which the truth was regarded; but logically it would still be there. Science, therefore, has to resign itself to the conclusion that its method cannot conceivably attain to absolute truth, and to make the best of it.

§ 27. Curiously enough this conclusion is fully confirmed by Formal Logic. It prides itself on pointing out that there is a formal fallacy involved in establishing truth by 'working'. The essence of this method is to argue that if a theory is found to work (after the proper precautions have been taken), it is true. If e. g. the events anticipated by a theory occur, and nothing occurs that could not be anticipated, it grows more and more probable until it convinces every one. But ought it logically to have done this? The logician declares emphatically, it ought not. For the argument suffers from an incurable flaw, which has been recorded as a 'fallacy' for over 2,000 years. It is a flagrant 'affirmation of the consequent'; symbolically, it argues that *if A is, B is, but B is, ∴ A is*. Now this is not 'cogent' or 'valid'. That *A is* can be proved only from the premiss '*only if A is, B is*', i. e. if A is the *only* theory which will account for the observed consequences. But this the fallacious method did not assert, and indeed could not assert. For that the best known is the best absolutely never can be proved (cf. § 26); and even if they happened to be identical, and we had somehow stumbled upon an absolute truth, we should never know that this was so.

§ 28. To the logician this fact only seems to prove the superiority of his conception of 'proof'. He infers, consistently enough, that no inductive reasoning from 'facts', no verification of hypotheses by events, can possibly amount to proof. What he seeks

to impress upon his pupils is that *verification is not proof and can never lead to it.*

He considers himself entitled to look down upon science accordingly, its evidence, its methods, and its reasonings, and to contrast them with the absoluteness of his own ideal of demonstration. He upholds its validity in spite of all the failures of the sciences to realize it. As a rule he seems willing to grant that some mathematical proofs amount to logical demonstration;¹ but if pressed he would confess that scientific truth was only probable, whereas certain metaphysical truths, such as the law of contradiction, alone were absolutely certain.

The scientist, of course, is not in a position to deny that the nature of his truth is such as has been stated: but he should not attempt to do so. He should content himself with scientific truth, and contend that at its best it is good enough for any one. And he can carry the war into Africa by a vigorous counter-attack.

(1) He can deny—for the reasons stated in § 13—that the logician's formal 'proof' is as cogent and formally valid as the latter supposes, and show that after a conclusion has been '*proved*' true, it has still to *come true* before it can be trusted to be 'true'.

(2) He can point out that there is a serious *lacuna* in the logician's plea for his notion of 'proof'. The logician has assumed that the only alternative to his belief in absolutely certain premisses is complete scepticism, arguing that it must be possible to start from certainty, because otherwise no knowledge would be possible at all. He then urged 'but there clearly *is* knowledge—the sciences attest it', and consistently inferred that absolutely certain premisses must be obtainable. The more or less obvious failure of his attempts to explain their genesis by 'self-evidence', 'intuition', 'necessities of thought', &c. (§ 15), could not deter him from clinging to his belief, because the principles themselves seemed to him to be inevitable and to admit of no alternative.

In fact, however, there *is* a *via media* between scepticism and absolutism, and science safely pursues it, though logic has over-

¹ This we saw (§ 4) is really a mistake: mathematical proofs are really hypothetical, and deduced from the initial postulates and definitions. They hold of the ideal objects of mathematics, but that they can be advantageously applied to reality is merely an empirical fact, and it is not inconceivable that the world should grow *more* recalcitrant to mathematical treatment, though actually it has grown *less* so.

looked it. It is *not* necessary to start with absolutely certain premisses, because it is possible to adopt premisses hypothetically, to take them as true for the argument's sake and for the purposes of the inquiry, to experiment with them, and to revise them in the light of the results of such experiments. Thus their value may be judged and established, *after* their adoption, by the experimental results, and they may come to depend logically upon these, and not upon the processes (analogies, suggestions, guesses, fancies, &c.) which led to their adoption. If they show themselves capable of advancing the science and solving its problems, confidence in their 'truth' increases progressively, and their initial assumption is justified. They *cease* to be 'hypotheses' and become 'facts', and even 'principles' beyond dispute. If they fail to 'work', they may be discarded in favour of others which are tried in their turn and similarly tested. Hence it is not true that what is uncertain to begin with must always remain so, nor is it hard to understand that hypothesis, willingness to believe, and belief may be the psychological forerunners of logical proof, which, nevertheless, rests not upon them, but upon the solid value of the results subsequently reached by their means. The certainty of scientific premisses then admits of indefinite growth, which at some point or other will overpower even the most obstinately sceptical temper. This point naturally lies at a greater distance from the starting-point for some minds than for others, but when it is reached, and when the last doubts and scruples have been overcome, the triumphant truth will *feel* absolutely certain, and to all intents and purposes will function as such. But the 'practical certainty' thus achieved will still be distinguishable in thought from the absolute certainty which logical theory mistakenly demanded. And logicians, from Plato downwards,¹ will be convicted of having failed to allow for the possibility that the certainty of premisses and principles may be a fruit of continuous experience and experiment, and to perceive that this is the method the sciences have actually employed. In short, necessary (needed)

¹ In *Republic* vi his whole argument for the existence of metaphysical truth, culminating in a supreme 'Idea of the Good', depends on the assumption that the 'hypotheses' of the sciences, being insecure originally, remain so until they are deduced from a (self-proving) 'unhypothetical principle'. This assumes, of course, that they cannot be confirmed empirically by the results of their working, and exhibits the *lacuna* of logic in a typical way.

'truths' need *not* be regarded as '*a priori*', if it is seen how hypotheses are consolidated by experience.

(3) The scientist can deny that the ideal case, contemplated with so much satisfaction by the logician, can ever occur in actual knowing. He can point out that if the logical apparatus of demonstration is to work, it must be supplied with premisses that are absolutely true. But whence is the logician to obtain them? The 'self-evident' principles and 'necessary' axioms, for which so much has been claimed, have been shown (§ 15) to be highly disputable, and are themselves in need of support and verification. The truths which the sciences supply abundantly are all products of the method to which he takes exception. There are no scientific truths which have not to be, and have not been, verified, and if verification is logically vicious, and cannot amount to proof, they are not absolutely true. But if the premisses of a demonstration are not absolutely true, neither can its conclusion be. What then becomes first of the value, and ultimately of the 'validity', of an ideal of proof which can never be exemplified by actual reasoning, and serves only to condemn it?

(4) The ideal of absolute certainty may be repudiated altogether, even as an ideal, for sound scientific reasons. It may be shown that if it were possible it would be scientifically undesirable. For it would mean the creation of absolute bars to scientific progress. If truths existed which were absolutely certain, this would mean that nothing more could be learnt about them, and nothing could be done to strengthen their position. No experience, no inquiry, no experiment, could any longer affect them, and add to or detract from their value. They could not, therefore, form avenues to further knowledge. They would simply be stops which would arrest scientific inquiry. But how could such things form an ideal of scientific knowledge? How could it be in the spirit, and to the interest, of science to recognize them? They would merely be for science brute facts which it was forbidden to investigate. And must not science on principle hold out for the right to inquire into everything, to test every belief, however true it may seem? How, then, can it be the ideal of science to adopt an ideal which would stop inquiry?

Nor will it suffice in reply to point to the fact that the sciences continually assume the truth of the premisses they argue from. For though this is often a convenient assumption for the purpose

in hand, it is one thing to assume the truth of premisses for the purposes of an inquiry, and quite another to assume it absolutely. For in the former case our assumption may be, and should be, accompanied by a consciousness that upon another and fitting occasion the premisses now assumed to be true may themselves be inquired into: to regard them, therefore, as absolute is to misinterpret their logical condition.

There are no good reasons, then, why the sciences should surrender to the arbitrary demands of the traditional logic, and sacrifice their practices which have been sanctified by the successes of 2,000 years to theories which sprang from a misunderstanding of scientific procedure, and have since lost all contact with it. The original mistake was pardonable, but it ought not to be regarded as an insult to logic to require it to understand the procedure by which the sciences actually progress.

§ 29. The scientist then should not be terrified by the charge that his 'truths' are 'only probable'. For it is better to be satisfied with probabilities than to demand impossibilities and starve. Moreover, a high degree of probability means 'practical certainty', i. e. confidence enough to move to action. Such certainty so convinces and satisfies the mind that it cannot feel more certain about anything; the logical gap between it and absolute certainty is psychologically negligible. We are sacrificing, therefore, nothing but a superstition, nothing that has any value for us, by renouncing the demand for absolute truth and demonstrative 'proof', and we gain in return a charter of liberty. For to admit the essential progressiveness of scientific truth and its indefinite capacity for improvement means unlimited freedom to research into truths which are infinitely perfectible, because they are never 'absolute'. The ideal of the infinite perfectibility of truth, and the infinite progressiveness of science, is more than an adequate substitute for the 'logical ideal' which is abandoned. For not only is it an ideal which works, but it really embodies a nobler aspiration than that which represented science as 'resting' in absolute perfection on fixed 'foundations' of 'eternal' truth. The sentiment which inspires this group of metaphors is given away by the word 'rest'. A science that desires to *rest* is one that is unwilling to *move* and unable to *advance*. Fixed 'foundations' are needed only for standing firm and standing still, and it turns out that what is strictly meant by 'eternal' is not that

truths last for ever, but that they are not related to 'time' at all, and so have really no application to 'events'.¹

On the other hand, a science which sincerely desires to progress needs fixed foundations as little as fixed ideas, and firm ground as little as assurances to 'rest' on. It needs only a starting-point, or jumping-off place, whence it can plunge into the unharvested seas of the unknown. Now the essence of a starting-point is to be a place you want to get away from, and its excellence lies in being such as to prompt you to leave it as easily and eagerly as possible. If, therefore, scientific 'principles' (*ἀρχαί*) are really to be starting-points, they need not, and must not, be so comfortable and so deceptively similar to 'absolute' truths as to tempt the scientific spirit to repose. They should be tentative assumptions which are gladly abandoned in the hope of reaching something better, stepping-stones to farther and higher things, which are valued for their consequences, and logically dependent on the conclusions to which they formed the premisses. The logic of science, therefore, has no reason to postulate stability or solidity for its initial principles: the most indispensable of them are only principles of method, and even of the tried and tested principles it arrives at the 'validity' (= strength) demanded is merely that they should be able to float the accumulated wealth of knowledge down the stream of time.

IV

§ 30. It is clear, then, that the time has come when Science should break decisively with the logical tradition, and proclaim a logic of its own which has always been implicit in its procedure. It must definitely declare that what it needs is not a logic which describes only the static relations of an unchanging system of knowledge, but one which is open to perceive motion, and willing to appreciate the dynamic process of a knowledge that never ceases to grow, and is never really stereotyped into a system. To show that such a logic is not inconceivable will be the endeavour of the concluding sections of this essay.

We have already had occasion to note many of the most important features of this logic. We have seen that logical, i. e. critical, reflection upon discovery must start from, and be guided

¹ *Formal Logic*, ch. xxi, § 7.

by, the conception of a scientific *problem* with which the process of knowing *experiments* (§ 21). This problem has, of course, to be attacked with the existing resources of a science, i. e. with the knowledge it possesses up to date. These resources form the scientific *capital* which is necessarily *risked* in research if it is to yield interest. It comprises (a) approved principles, (b) known facts, and (c) established meanings of words. About each of them a little more may advantageously be said.

(a) We have seen (§ 15) that the principles of any science could not rightly be conceived as inscrutable, ultimate, absolute certainties of divine descent, and acknowledging no human ancestry. We saw that they could be understood only as hypotheses which reflection upon a problem had somehow suggested to an ingenious mind, which had been provisionally adopted in order to explore and organize a subject of inquiry, and had finally been verified and confirmed by their success (§ 15 (c), § 24).

The principles thus accepted by a science are often regarded as descriptive of fact when they are merely methodological and convenient,¹ but this is a point of secondary importance. And even the most amply verified principles never quite lose their hypothetical character. So long as they are used, their meaning, scope, and truth are not absolutely fixed. They can be extended, restricted, and modified by the working of the principles.

§ 31. (b) It is really obvious to any critical reflection that when a science appeals to 'facts', it is really appealing to the facts *as known*, or supposed to be known. It cannot from the first presume its knowledge to be absolute, and, *pace* some of our 'neo-realists', ignore the question whether the alleged facts are facts at all, and so pretend to start from 'the facts as they really are'. Such uncritical temerity would only conduct to insoluble pseudo-problems like that with which King Charles plagued the nascent Royal Society, as to *why* the weight of a bucket full of water was not increased when a fish was added to it. If, however, it is acknowledged that the 'facts' involved in a scientific inquiry are always relative to a definite state and date in the history of a science, several important corollaries follow.

(1) Being dependent on the condition of the science, the facts

¹ e. g. the 'accidental' distribution of variations in biology, for which see *Humanism*, pp. 146-50, and the postulates of causality and determinism in science generally (*Formal Logic*, ch. xx, § 6, and *Studies in Humanism*, ch. xviii, § 4).

of a science will not all be 'facts'. That is, not all that is relevant to the interest of the science will actually be within its cognizance, not all that turns out to be fact, and is antedated when it has been discovered, is as yet recognized as fact. It will be this fact, moreover, which constitutes the science a field for inquiry and renders it progressive.

(2) Though the 'facts' of the moment fail to include all the facts, they often manage to include too much. The 'facts' are not all fact. They include unknown, and often large, amounts of prejudice, illusion, error, superstition, and other remnants of the lurid past and stormy youth of every science. It is useless to repine at this inevitable consequence of past history, and childish to try to purge it away by defining as science only what *ex hypothesi* is free from such contaminations. To restrict the logical interest to science *qua* science, which is by definition infallible, is to forbid any logical treatment of the sciences we actually possess. But the logician should surely be encouraged to study the processes by which the sciences correct their initial errors and consolidate their acquisitions.

(3) It follows on both these grounds that the 'facts' of which a science takes cognizance will be subject to change. As the science grows, 'new' facts will come into it, and old facts will be discarded as erroneous. In particular, facts which at first were only inferred on theoretic grounds will be actually observed, even as 'Neptune' was the fruit of a theory about the perturbations of Uranus. Hence the antithesis of 'theory' and 'fact' must not be taken as absolute: they must be expected to play into each other's hands. It is the business of theories to forecast 'facts', and of facts to form points of departure for theories, which again, when verified by the new facts to which they have successfully led, will extend the borders of knowledge. Incidentally, however, this interaction between fact and theory often renders it difficult to decide whether a scientific doctrine is better regarded as a 'theory' or as a 'fact', and leads to differences of opinion. But it can hardly be wrong to advise the scientific mind to practise hospitality towards new facts, while it is no less fitting to show generosity towards old servants that have done their work and can now advantageously be retired. It is ungrateful to abuse them as 'errors', and to despise them with the lofty contempt of the higher knowledge to which they have conducted. And in both

cases the truly scientific attitude may be attained if an element of fanaticism is not imported into the conception of truth by attributing to it an absoluteness which no human truth in fact possesses.

(4) The same need for tolerance is emphasized by a further corollary of the conception of fact which has been advocated. It seems at first a paradox, but on reflection appears to be evident, that the 'facts' will not only *look* different but may really *be* different from different points of view and for different purposes. Once we permit ourselves to consider this possibility we shall easily perceive that there often are conflicts between 'facts', such that they cannot coexist for an abstract logic, while, nevertheless, each of the conflicting facts may be intelligible relatively to its own presuppositions and true under its own conditions, so that the 'contradiction' between them is generated merely because the logical statement has abstracted from the special circumstances of the case.

This situation is, of course, recognized very familiarly and universally in the case of *value-judgements*. We are all willing to admit that one man's meat may be another man's poison, that it is vain to dispute about tastes, and that the same mode of living does not suit all constitutions and all circumstances. We recognize, too, that profound differences of opinion and attitude exist, and always have existed, among men. The temperamental differences which make e. g. one man indolent another enterprising, one man daring another prudent, one a conservative another a radical, one an optimist another a pessimist, are so deeply rooted in human nature as to be, humanly speaking, ineradicable. And if so, must it not be conceded that situations occur which will inevitably, consistently, *and rightly*, be judged differently by these different persons?

Again, it should be noted that these differences in valuation are not merely subjective: they spring from objective differences in human nature, and are as objective as any other facts about it. For example, that certain persons dislike pork (because they cannot digest it), and hate cats (because their presence makes them feel ill), rests as much on a physiological fact of their constitution as that others suffer from 'hay fever'. Similarly, it is quite plausible to contend that 'every little boy and girl that is born alive, is born a little liberal or a conservative', and certainly the normal growth of conservatism as the individual mind

ages is proof enough that changes of belief depend on psychological law, and are correlated with the hardening of tissue which is a general symptom of senescence. Again, is it possible to imagine a situation so bad or so good that it cannot be interpreted either optimistically or pessimistically? In most cases either interpretation is quite easy, and the choice between them is effected by sheer temperamental bias. If, then, we succeed in doing what the natural man will always find difficult, and regard such differences of opinion in a scientific and non-partisan way, must we not admit that *both* the conflicting standpoints are inevitable and justifiable? Neither can be pronounced wrong in general and *per se*, though in regard to a particular problem or occasion either may be. Let us conclude, then, that it may really be a 'fact' that the 'facts' justify one interpretation and attitude to one mind and another to another.

This argument is reinforced by the further consideration that even the most objective statements of fact involve *value-judgements* in their ultimate analysis. For they express, often explicitly and always implicitly, the choices and valuations by which a variety of pretenders to reality have been examined and sifted, and the most valuable have been declared 'truly real'. We have seen that in a scientific inquiry the 'facts' must always be taken as *alleged* facts, discovered up to date; hence a science must always be ready to defend the 'facts' it recognizes, when they are challenged, and to show wherein they excel conflicting allegations. The accepted 'facts' of a science, therefore, are always allegations which are thought to possess greater *value* than any known alternative; hence no sharp or absolute distinction between judgements of fact and judgements of value can be maintained. It becomes, moreover, quite possible that incompatible allegations of fact may in the actual state of a science be so nearly balanced that there is no convincing reason to prefer one to another, or at any rate none that could prevail against any ordinary temperamental bias. Consequently, in such cases the bias will condition the visibility of the 'fact'; it will be bathed in a 'subjective' atmosphere, and the 'eye of faith' will be necessary to perceive it. No doubt such situations are inconvenient, and repellent to the scientific spirit; but they do not occur only in the misty regions of religion and philosophy, and scientific alternatives like 'chance' or 'design', 'miracle' or 'law', 'mechanism'

or 'vitalism', determinism or indeterminism are essentially of this order. There is no reason, therefore, why logic should not recognize them and acknowledge that the scientific 'facts' may be ambiguous, in the sense that further experience and experiments are needed to determine their character. As a rule, to judge by the past, further inquiry will resolve the ambiguity; but it may well be an illusion to assume that it must do so, and in some of the most important cases the decision will certainly be long in coming.

Thus the student of animal behaviour will probably long be left with a choice between minimizing the displays of animal intelligence and assimilating them to the human, while it will probably always be possible to put a pessimistic or an optimistic interpretation upon the facts of life as a whole.

A scientific logic therefore should radically disabuse the mind of any excessive trust in 'facts'. It is a superstition that 'facts' are plain, straightforward, and easy to discover; they are often subtle and recondite and relative to circumstances, changing their aspect to suit their scientific environment like any chameleon.

§ 32. (c) In considering the use of words in research, one cannot of course overlook the obvious fact that the employment of words is primarily determined by their established meanings, and that these greatly limit our freedom to use them as we please. Words naturally and inevitably suggest their established uses by their mere sounds, and should always be used with a proper respect for their past history and present meaning. To be sensitive to this appeal is the mark of the educated scholar; but it does not require the investigator to exhaust his energies in vain attempts to stereotype absolutely the current meanings, and so to deprive words of their essential function. For their essential function is after all to be instruments for the conveying of actual meaning, and actual meanings are always more or less new (cf. § 12). It occurs to a particular person in a particular situation to express and convey a meaning which has never in its full concreteness occurred before. If the novelty about this situation is appreciable and important, it may well be that the old words will not fully succeed in conveying the new meaning; and yet we shall always endeavour to use them, and select from the accumulated wealth of language the words which will suffice for our purpose. For the alternative is worse; we cannot always be coining new words

for every new meaning we may desire to convey ; they would not be understood or remembered, and even if they were, a science that employed nothing but technical terms, and was moreover compelled continually to change them, because it would not use them to convey new meanings, would speedily degenerate into an abstruse game, and could make no progress. How impracticable such a policy would be may be gauged by the grave inconvenience which even now systematists cause by so frequently changing the scientific names of plants and animals. It is indispensable, therefore, that words should retain a certain measure of plasticity, in virtue of which they can be transferred from old situations to new and be used to convey new meanings. Nor is there usually any difficulty about thus imposing new duties on the old terms; under the particular circumstances of the situation even wide departures from the established meanings may remain intelligible, and so the progress of science is not impeded.

The traditional logic, however, cannot treat the matter so lightly. For the plasticity of words may always engender a conflict between the old meaning and the new, between the scientific use of terms and the traditional conventions about their use. And this can always be represented as a defiance of the 'laws of thought'. For if the meaning of 'A' may be altered by the growth of knowledge, it will no longer be true that everything once called 'A' is truly A, nor that what was once incompatible with A will continue to be so for all time. Hence it is no longer necessarily true that 'A is A', and that A cannot both be and not be B. It may be both in different senses, and in what sense 'A' and 'B' should be taken may be precisely the point at issue. Thus verbal contradiction ceases to be a clear proof of error; it may be only a much-needed warning that our terms have been developing new meanings. Hence, the 'laws' of Identity and Contradiction lose their last claims to be regarded as statements of fact, and have to be conceived as ideal postulates of just so much stability of meaning as is requisite for effective understanding.¹ They can be applied to reality only hypothetically, i. e. experimentally, to discover whether in a given situation the natural growth in the meaning of the terms may *rightly* be treated as irrelevant, and does not vitiate the conclusion which the reasoning forecasts. Now this problem can never be

¹ Cf. § 8 and *Formal Logic*, ch. x.

settled *a priori* by reasoning, but only by subsequent experience. Reasoning may forecast a result which experience fails to confirm; when we discover that comets' tails are not attracted by the sun but repelled, we do not declare the facts 'contradictory', but modify our notion of 'gravitation', and conceive it as inferior to 'light pressure' in its effects upon particles of a certain minuteness.

It follows that no merely logical scrutiny of the terms of an argument can ever settle a scientific question. If a 'contradiction' is real, it means either a difference of opinion between those who make the incompatible assertions, or, in the case of a real 'self-contradiction', the uttering of 'nonsense' and a failure to propound a meaning at all. But even the most glaring 'contradictions' may only be apparent, i. e. verbal: when we inquire into their actual meaning we may find that they refer to a context in which its terms are perfectly compatible. Thus the existence of a 'round square' may be predicated of London, and a 'triangle's' angles may equal or may exceed two right angles, according as it belongs to Euclid's geometry or to Riemann's.

§ 33. The problem of discovery, therefore, is never one of which the solution can be guaranteed in advance. The resources of a science are never sufficient to assure us of a prosperous issue of the research, though, rightly understood, they yield important safeguards. A recognition of the instrumental value of words as ancillary to meaning, and of the limitations under which they labour, will guard the inquirer against the terrible verbalism to which logic has been enslaved. A critical attitude towards allegations about 'facts' will enable him to minimize the dangers of error, deception, and bigotry. A conception of 'principles' as working hypotheses will discourage a servile and superstitious reverence for them, and justify the fullest freedom to experiment with whatever ideas hold out hopes of verification and of scientific progress. Together these three considerations will pretty thoroughly emancipate inquiry from the shackles of any mechanical scheme of 'proof'. Indeed, proof in the old formal sense will have become a chimera. It will no longer be possible to cherish the belief in a self-sufficing, self-satisfied form of absolute proof, of which the pure logician imagined himself the possessor and retailer.

Scientific proof, on the other hand, will be neither absolute nor formal. It will not be absolute, because it will always be relative

to the actual condition of a science; it will not be formal, because it will never be absolute. It will only be the best known interpretation, and will always imply alternatives, to some of which it may wrongly have been preferred, while to others it may be destined to succumb (§§ 26, 27). It will be 'valid' so long as it is the strongest; but to it, as to the priest of Diana Nemorensis, as to Uranus and Cronus, will come the day when it is invalidated and superseded by a stronger and better, descended, it may well be, from itself. Scientific proof then will always be an *evaluation* of evidence, a making the most of the available resources of a science, a question of the *comparative values* of rival interpretations.

It stands to reason that such an evaluation cannot operate merely with the criteria of formal logic. Indeed, of the processes known to the traditional logic, only those which *cannot* be represented as 'formally valid' will be exemplified in scientific knowing. It will not be possible to find any genuine cases of absolute certainty or unconditional proof; but analogies, probabilities, hypotheses, alternatives, even fallacies and fictions, will abound, and will somehow have to be discounted. Clearly the evaluation of such things will be a delicate affair; it cannot be accomplished by reciting *Barbara Celarent* and crudely applying a few simple mechanical formulas. It will demand the energetic co-operation of the whole intelligence, and indeed of the whole personality, and cannot scorn the aid of psychological factors. For it is plain that the evaluation of a complicated scientific situation will require both expert knowledge of scientific detail and philosophic grasp of general principles and connexions; it will need also 'tact', 'judgement', an 'eye from experience', and a host of similar qualities that elude precise verbal formulation. It will no longer be practicable to flatter mediocrity and dullness, and to impede discovery, by proclaiming methods that dispense with imagination, ingenuity, originality, boldness, enterprise, and vainly endeavour to put genius for discovery on a par with mindless pedantry in applying stereotyped and sterile rules.

§ 34. But just because a logic that recognizes the actual process of discovery does not presume to dictate formal methods to the discoverer, and leaves him a very free hand, it does not relieve him of any of the responsibility for conducting his researches to a prosperous issue. As there is no longer any pretence that any logical machinery can be devised to guarantee success,

success and failure become his personal achievements. If he fails, he can no longer plead that it is not his fault, seeing that he has kept every letter of the law and broken no logical rule. This may be precisely *why* he failed. Perhaps he should have taken risks. He may have gathered such enormous masses of fact that he could no longer see through them, nor select the few that were relevant to his problem. He may have been so sensible of the need for caution that he dared not speculate or move. He may have devoted himself to unimportant problems or missed the important sides of important problems, or have wandered away into barren wastes of dialectics, or have got bogged in a mire of verbalism, or have pursued elusive phantoms of unverifiable speculations. For there are clearly many ways of failing. Only in whatever way he fails, his personal failure is *pro tanto* a failure of science to progress. Every science has somehow to get hold of a clue to guide it through the labyrinth of fact, and this clue has to lead it right, though it need not 'follow necessarily' from previous knowledge.

Nevertheless, if, and in so far as, a researcher succeeds in making a discovery, some of his personal credit is reflected upon his methods *ex post facto*. Their success does not, of course, establish their formal 'validity'; but it stops the mouth of those who argued that what is 'invalid' must be worthless. Methods that succeed must have *value*, a greater thing than 'validity', however far and however boldly they departed from the canons of formal proof. The success has shown that *in this case* the inquirer was right to select the facts he fixed upon as significant, and to neglect the rest as irrelevant, to connect them as he did by the 'laws' he applied to them, to theorize about them as he did, to perceive the analogies, to weigh the chances, as he did, to speculate and to run the risks he did. But only in this case. In the very next case, which he takes to be 'essentially the same' as the last, and as nearly analogous as is humanly possible, he may find that the differences (which always exist between cases) are relevant, and that his methods and assumptions have to be modified to cope with it successfully. But he should not be discouraged. For the ultimate ground of the whole cognitive procedure by which we analyse the flow of events is empirical. It is only an empirical fact that knowledge is possible, i. e. that the course of events is such that human minds can analyse it at all, that is, can pick out and construct cases of 'the same', of which the course can be predicted by means

of the (verbally) stable formulas we call 'the laws of nature'. For logic at any rate these laws are neither supernatural behests nor metaphysical entities: they are forms for classifying happenings, in which the blanks have to be filled in with the variable values of the particular happenings. What the *right* values are, and even what is the *right* formula to apply, will always depend on the particular case which forms the actual problem. It is only the empirical fact that the differences between problems may so often be treated as irrelevant which generates the illusion that problems may be solved in advance by general formulas: in reality every problem in its full concreteness is unique, and we are never absolutely sure that it will submit to the rule we apply to it. Hence it is solved only when we come to it and find it amenable to our methods; in principle it eludes logical prediction, because it can be known as a 'case' of the successful 'law' only *after* the experiment has confirmed the forecast. To the inquirer, therefore, no result can seem certain until it has occurred; it is only *ex post facto* that the logician can describe it as an indubitable case of some law from which it follows of necessity. But in so doing he has changed it, and repudiated the duty of describing actual knowing. All he is doing is to rearrange a piece of knowledge, acquired without his aid by means he condemns as illicit, in the order he is pleased to call 'logical'. This order has a certain aesthetic value, but it is emphatically *not* the order of discovery, and throws no light on the process of acquiring knowledge.

§ 35. What function then can be assigned to the logician's reflection on the workings of science? In view of his failure to substantiate his claim to have provided a model for inquiry in his scheme of 'proof', it might seem that he was either useless or pernicious. Useless, if he merely devotes himself to constructing 'ideals of proof' which he admits to have no relation to the actual problems of science; pernicious, if he is prompted by these ideals to make demands with which no science can comply, and to deliver judgements which would paralyse the science that attempted to carry them into execution. Fortunately, he cannot enforce them, and the sciences actually go on their way, ignoring such 'logic'. The proper inference from his impotence is that he would do well to take up a position which is more useful and more influential, if less pretentious.

Let the logician then give up the pretence of dictating to the

sciences and of judging the worth of scientific truth by rigid forms of absolute proof; let him abandon the vain pursuit of 'validity'. Nay, more, let him renounce the claim to determine the scientific value of an argument by a mere inspection of its logical character. Let him confess that what alone he can criticize is the incongruities in its verbal expression, and that its real value lies beyond his ken. If he will concede all this, his reward will be that he has vindicated for logic an important right of more real value than the claims he has abandoned. For he will have obtained the right of summoning the sciences to state their results in intelligible and consistent terms, and to confront them with a problem when they do not. Just because he does not presume to condemn them, and no longer ventures to declare that incompatible and verbally 'contradictory' results are necessarily wrong and worthless, but only urges that they are not intelligible as they stand, and need to be reworded or inquired into farther, he gains the right of *raising problems*, and stimulates the sciences to proceed to solve them.

It should be noted, moreover, that the problems thus raised are general, not special, i. e. are properly logical. The problem about 'contradictory' results is one about meaning, for contradictory assertions cancel each other's (apparent) meaning. This enables the logician to keep the sciences engaged upon the logical problem of solving the discrepancies between their results, so long as the sciences do not form one complete and congruous system, i. e. indefinitely.

Similarly the denial that truth is absolute is a general truth that affects all the sciences. It should stimulate them all, for it means that no statement is so perfect that it cannot be bettered and that no limits can be set to the progress of science.

Other topics which are 'logical', because they concern the general significance of scientific procedure and not the solution of particular problems, are the nature and importance of selecting 'facts' and the 'laws' they are taken to exemplify, the experimental attitude and the framing of hypotheses, the evaluation of probabilities and alternatives, the estimation of relevance and of verifications and of the amounts of the latter which are requisite and the sorts of it which are relevant. On all these points logic has hitherto had little or nothing to say, mainly because they did not lend themselves to formal treatment. Lastly, there are two extremely important subjects, which are so vital to the logic of dis-

covery that a brief discussion of them may fitly conclude this essay. We may call them the problem of Novelty and the problem of Risk.

§ 36. In Logic we are not concerned with the metaphysics of Novelty, i. e. with the problem of whether there ever enter the world things that are really and truly unforeseen and unpredictable, that pop into it from nowhere, and if so, whether and how we can understand such things. This problem is deep and difficult, and so, until recently, philosophers have fought shy of it, and used to settle it off-hand by a flat denial that such things could be in a 'rational' universe. But now that M. Bergson has given us a radically new metaphysic, and that we are beginning to perceive that the principles used to dispose of the matter, viz. causality and the conservation of energy, are essentially methodological, the question has become an open one.

Logic, however, has no need to probe it; it can treat it more simply. For its purposes it can, and must, treat novelty as a real logical fact. It is a psychological fact, and logic must note it, that every moment of our life has for us a certain flavour of newness; it is also a fact that every real judgement that is ever made has a certain relation to novelty.¹ Its maker believes, either that it embodies a new truth, or that though known to him it is new to his hearers. If he did not believe this he would have no motive to make it. It would be stale repetition, devoid of interest or value alike to him and to others, whom he would merely bore by telling them what they, too, knew already.

So far, then, the logical nature of novelty seems simple. It gives rise to problems, however, when we consider the relation of the new truth to the old. It is clear, in the first place, that the new truth must affect the old. Even where we are willing to minimize its novelty, and to call it merely an 'extension' of what we already knew, it must modify it and change its value. For in the light of the new developments the old truth *means more*: it has relations in an enlarged field of knowledge. Moreover, the new truth is often not merely an extension but also a *correction*, and the effect of the correction may sometimes be revolutionary. It may even seem to upset the old beliefs altogether, though

¹ The 'novelty' which is claimed for the conclusion of a syllogism is only one case of this: in the traditional interpretation it is hopelessly at variance with the demand that it shall also follow from its premisses of necessity. Cf. *Formal Logic*, ch. xvi, §§ 8-10.

human ingenuity is far too fertile in building bridges (often only verbal) from the old to the new to allow this impression to be permanent. Still in all these cases there is more or less discrepancy between the new and the old.

The logician, however, should insist that this fact should not be blinked. He should recognize the discrepancy, and emphasize its significance, just because for other purposes it is usually convenient to ignore it. For it is not only the source of real ambiguity in the facts of science, and of the important differences of opinion among men and of their obstinate persistence, but the justification of the policy of open-mindedness and toleration which he regards as necessary to scientific progress. Inasmuch as of every discrepancy between the old truth and the new it will be possible to take two views, and either to cling to the old or to put one's trust in the new, there will always be a party of conservation and a party of innovation, or otherwise a conservative and a liberal bias, in science as in politics. It is, moreover, futile to discuss, in the abstract, which of them is right: for it would clearly be fatal to go all lengths with either. Science could make no progress, either if every novelty were at once condemned and suppressed because of its failure to conform with the accepted doctrine, or if everything new were hailed as true regardless of its concordance with the old truth, so that the course of science became a series of radical revolutions that had no consistent direction. In concrete cases of course both sides are sometimes right, though historically the stronger bias men have shown has been the conservative. What usually happens is that the new truth is first denounced as an immoral invention which is subversive of all intelligible order and cosmic rationality; it is then quietly assimilated and not infrequently converted in the end into the strongest support of the beliefs it was alleged to subvert. But it would be a real gain if logic, by viewing this natural feature of knowing in its generality, could induce men of science to take it more calmly. If it were generally recognized that every claim to new truth, however great the advantages it promises, necessarily entails certain inconveniences, because the old beliefs and notions have to be modified and readjusted, and this may involve too great an effort to be worth while, or an effort too great for certain minds, it would be seen that there are two sides to every question, and that both may be in a way legitimate. If, in addition, we recognize that

the parties concerned usually have a bias which may render them dangerously blind to the case of the other side, and that both should be admonished to discount their bias duly, we shall have done not a little to secure fair-minded¹ consideration, reasonable discussion, and intelligent choice between the alternatives. And all this surely conduces to scientific progress.

It is clear, then, that the problem of relating the new to the old always exists, and has a vital influence on the fortunes of every science. But it is not capable of any formal or abstract solution *a priori*. Which is to be preferred is a matter which must be left to the expert who is cognizant of the circumstances of the case: logic can help only by broadening his mind, and putting him on his guard against his own personal bias, which might otherwise unconsciously determine his decision.

§ 37. To admit that scientific inquiries concern problems, and that to every problem (at least) two solutions may be propounded, between which a choice has to be made, is to admit that knowledge *must take risks* in order to progress. For there is always the risk of choosing the wrong solution of a problem, i.e. the one which works *less* well, just as there are always risks of choosing a bad problem and of selecting the wrong facts and the wrong theories to explain them withal. Nevertheless, we ought not to resent this fact. For the taking of risks is inevitable: we cannot escape it either by refusing to inquire or by refusing to decide. For in either case we run the risk of missing a valuable truth.

It is better, therefore, to recognize that every act of knowing must involve risks, just as every act of living does; and this for the simple reason that knowing is an activity comprised in living, and every judgement is an *act*, which might have been left undone, or for which another might have been substituted. The readiness of the new conception of logic to emphasize the existence of risks in all reasoning, and to sanction the willingness to take them,

¹ Usually, but wrongly, called 'dispassionate' or 'disinterested'. What is wanted is, not that the inquiring mind should take no interest in the conclusions it considers, but that, though it cares keenly and even passionately for one of them, it should yet be capable of sufficient self-control to consider fairly the case *against* the conclusion it favours. This mental attitude is probably best secured by caring more for truth than for a party victory, and is denominated a 'disinterested love of truth for its own sake'. But even so we love what we deem the truth, because it is the *best* thing to believe, and better (on the whole and in the end) than anything else that is propounded.

contrasts markedly with the vain efforts of the old logic to play for safety, and to make no move that was not absolutely necessary (cf. § 10). This was why it postulated absolutely certain premisses, and would contemplate nothing but 'valid' forms of reasoning. In its desire to elevate its proofs above the perplexities and vicissitudes of mundane problems, the old logic was expressing and comforting a deep-seated human craving: for life is so replete with the most hideous risks that it is a natural instinct to clutch at any promise of security. Hence the passionate and almost religious reverence with which formal logic has been regarded for over 2,000 years. Many philosophers still worship the syllogism, because it seems to them an incomparable exemplar of absolute security firmly fixed in the sphere of immutable necessity far above the flux of phenomena, which it illumines with its steady radiance. But to exalt in this way its ideal of proof, the old logic had to pay a heavy price. The price was cutting the ideal wholly adrift from the actual, contemplating exclusively a situation which could never occur in real life, and leaving all actual inquiry to its devices, unstudied, uncriticized, and unaided. Thus, the splendid aloofness of the logical ideal was purchased by a total repudiation of actual science. To many philosophic minds this price does not seem excessive. The more useless truth is made to appear, the purer and more admirable it seems to them. An ideal, they think, should be like Aristotle's 'god'; it should attract, without uplifting, and without running the risk of contamination by the dirty work of life.

These philosophers have always claimed for their attitude that it is philosophic *par excellence*. But their claim, besides being based on a somewhat rare personal idiosyncrasy, is not really sound. It is neither self-consistent nor a sound policy for life. An ideal which repudiates the actual, and yet professes somehow to be its exemplar, is left in the impossible condition of the Platonic 'Idea'. If it were as superhuman as it claims to be, no human mind could even speculate about it. And we have seen (§ 13) that it is not in the end possible to devise a form of proof which is bomb-proof against the attacks of experience and superior to verification.

Is it not wiser, then, to admit that life has its claims upon science, and science upon logic? We simply *must* have a science that can handle human life and meet human needs, and does not degenerate into a game with arbitrary and fantastic rules which

depart from the actual conditions of life in any direction and to any distance unrestrained imagination carries them; and our logic must deign to study such a science. If to do so it has to 'scrap' its antique 'ideals', to abandon its pose of an inhuman, impassible, infallible aloofness, and to interest itself in the doubting, questioning, guessing, trying, risking, blundering, correcting, achieving that make up the sum of human knowledge, it will receive an ample reward in the gratitude of man for a logic that has entered his service, and in the salutary influence which it will exercise upon his actions.

Conclusions

(1) We have shown, negatively, that the notion of a form of proof, by which conclusions can be absolutely demonstrated by dint of pure logic alone, is a delusion. No such form can be constructed (§§ 13, 15), and if it could, it could neither find scientific material worthy of it (§ 28), nor contain the material which is fabricated by the sciences.

(2) We have thereby shown that formal logic cannot represent the logical nature of discovery or of any of the processes of actual knowing, and must condemn them all as 'invalid' (§§ 18, 20, 26, 28).

(3) We have seen that a logic which attempts to understand actual knowing cannot prescribe to the sciences how they are to solve their problems (§ 33).

(4) But it *can* grasp the general character of scientific procedure, appreciate its difficulties and dangers, understand the expedients for meeting them, and trace it to its roots in the constitution of the human mind and in the needs of life (§ 35).

(5) In virtue of its general grasp of the aim and method of the sciences a logic of science can at times offer advice to scientists: it may draw their attention to the general problems which their work involves, but which are apt to be overlooked by specialists, such as the claims of consistency and novelty and the regulation of risks (§ 36). Or, better still, if they will study it themselves, it may broaden their minds and enable them to handle these general problems for themselves far more effectively than a pure logician could do it for them.

(6) By abandoning its pretensions to rigour and conclusiveness logic does not really lose: it gains immensely by coming into contact with science and life, and becoming of use in the world.

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